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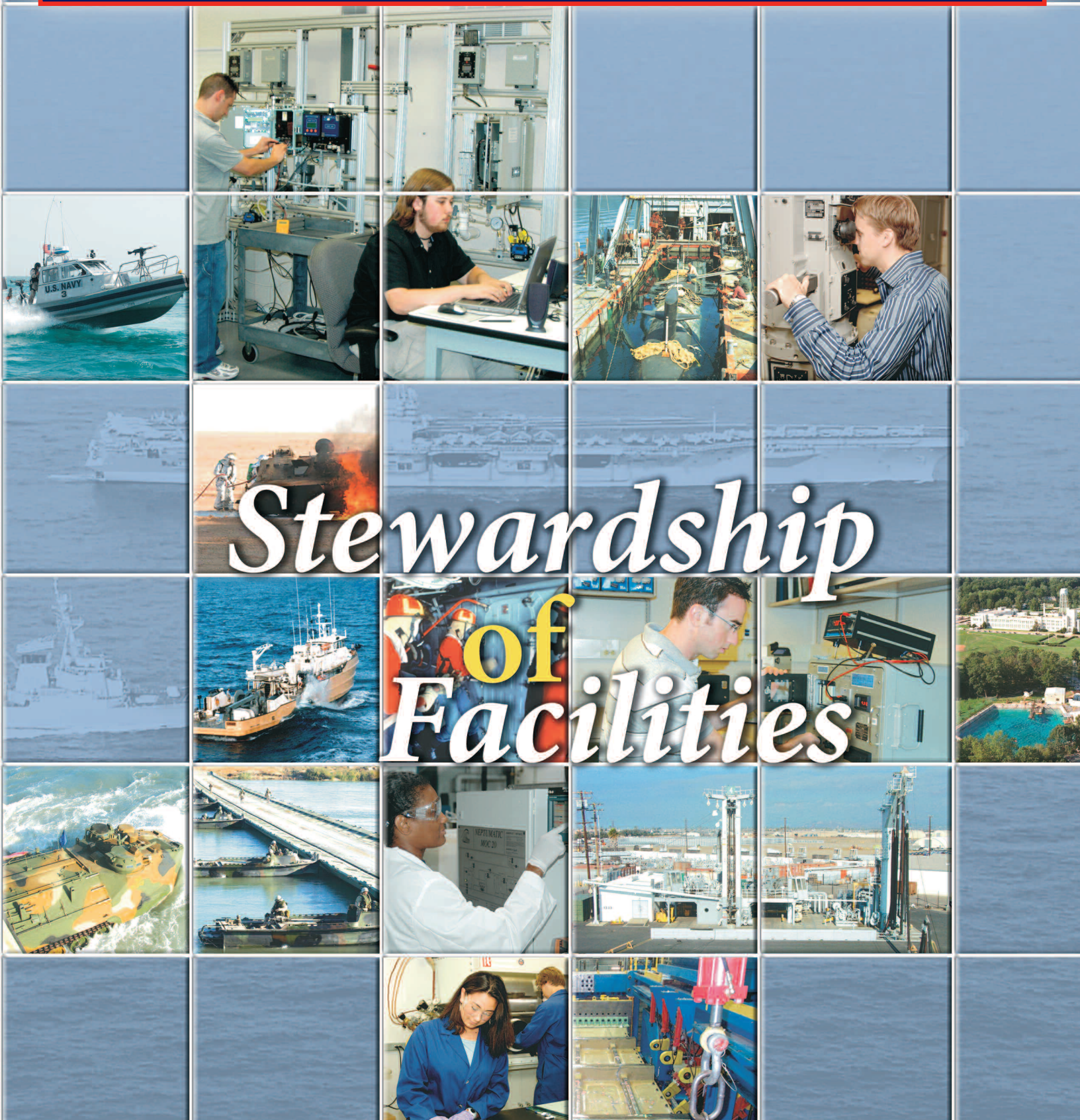

Stewardship of Facilities

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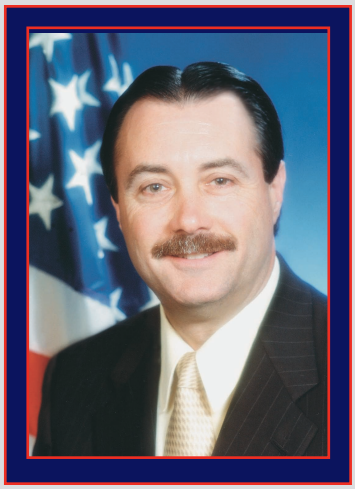

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Stewardship of National Assets Supports the Navy's Vision

Ships & Ship Systems NotePAD

By Charles (Randy) Reeves

With the Navy engaged in transforming to enhance its military capabilities to protect America's worldwide interests, the Ships and Ship Systems (S^3) Product Area (PA), along with the rest of the Warfare Center, is challenged to not only support the Navy's future needs but to do so while reducing costs, streamlining processes, improving productivity, and advancing technology. Our last issue of SEAFRAME described the S^3 PA's efforts to serve as good stewards of our capabilities in terms of people and knowledge. This issue focuses on stewardship of the facilities, which are considered national assets, that the S^3 PA uses to support advancing technology for the fleet of today and tomorrow.

The Warfare Center provides an infrastructure of one-of-a-kind facilities supporting the Navy's unique needs. These facilities are owned and operated by the government solely because no business base exists for these capabilities, making it unprofitable for industry to support. The facilities are available for use by academia and industry through "work for private parties" agreements, when appropriate. The product area directors are responsible for sustaining these facilities to support technical authority and provide technical solutions and knowledgeable, independent technical assessment of services/products available to the Navy.

The national assets supporting the S^3 PA are located throughout the country and are linked with several Warfare Center divisions. In West Bethesda, the Carderock Division's Towing Basins (shallow water, deep water, and high-speed) are used by both Navy and industry for ship model resistance, self-propulsion, and flow measurement experiments. Additionally, the site's Maneuvering and Seakeeping Basin (MASK) is used to model the full-scale motions of ships, platforms, and mooring systems in waves. And in Memphis, TN, the Large Cavitation Channel is one of the world's largest and most technically advanced water tunnel facilities, providing significant cost savings for testing large-scale models of advanced ship and submarine system designs and full-scale torpedoes in a controlled environment.

Carderock Division's Philadelphia site is home to a vast array of machinery land-based engineering and test sites, including the Gas Turbine Development Facility, which consists of the DDG 51 Land Based Engineering Site and Intercooled Recuperated Gas Turbine Facility. The site is used in a variety of components and system-oriented tests.

Carderock Division's Acoustic Research Detachment in Bayview, ID, features Lake Pend Oreille–a large, deep, and extremely quiet body of water, ideal for acoustic testing. The Southeast Alaska Acoustic Measurement Facility is the Navy's primary acoustic engineering measurement facility in the Pacific, used to determine the sources of radiated acoustic noise, assess vulnerability, and develop quieting measures. Carderock Division's South Florida Testing Facility is the only ship, submarine, and mine-effectiveness test range with simultaneous air, surface, and subsurface tracking capability.

Port Hueneme Division's Underway Replenishment (UNREP) Test Site is the only fully equipped and operational UNREP test site and features modern constant tensioned fueling and cargo systems with Navy standard equipment representing the latest configurations for both the delivery and receiving parts of the system.

In Indiana, Crane Division offers a Battery Test Facility that was specifically designed to provide a variety of explosion-proof testing cells as a way to negate the hazardous material and personnel safety problems associated with battery testing.

The facilities supporting the S^3 PA provide engineers with the unique tools needed by technical warrant holders to solve the Navy's distinctive problems. Through careful investment and stewardship, we can ensure the S^3 PA continues to provide the focus, advocacy, and technical capabilities necessary for meeting the diverse needs of 21st century naval warfare.

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The SEAFRAME staff reserves the right to edit or rewrite all submissions.

On the cover: The Ships and Ship Systems Product Area is committed to maintaining research and testing facilities to meet the diverse needs of 21st century naval warfare. The cover images depict some of these unique laboratories and test sites often described as national assets.
Photos provided by NSWC Carderock and Port Hueneme Divisions.
Cover design by Gloria Patterson.

TABLE OF CONTENTS

For More Information on Sites Supporting the S^3 PA:
www.dt.navy.mil, "Our Capabilities," "Our Facilities"
www.phdnswc.navy.mil/FleetSupport/uniquecapabilities.asp#Underway

Warfare Center Investment Board

Looking Out for the Navy's Technical Needs in the Short– and Long–Term

By Peter Montana, Brigette Murray, and Leslie Spaulding

The Warfare Center Investment Board (WCIB) was chartered in 2004 as part of the overall Warfare Center integrated planning process. Its mission is to ensure that investment proposals from the Warfare Center divisions, product area directors, and process executives reflect an appropriate balance between competing short- and long-term naval needs and to assure that vital technical capabilities, including facilities, provided by the divisions are available for today's and tomorrow's fleet. In the long run, the WCIB aims to ensure that requirements drive the size of the investment pool and that these investments are based on warfare analysis, emerging needs, discussions with existing and new customers, and the Warfare Center Board of Directors' planning guidance and strategic investment objectives. The board also serves to minimize duplication of effort and overlap amongst the division investments, wherever possible.

Another board, the Warfare Center Policy Board, develops and establishes the policies that guide Warfare Center investments and investment strategies. These policies are used by the WCIB to oversee investments in the areas of the Capital Purchase Program (CPP), military construction (MILCON), and overhead. Without the WCIB's approval, no investments can be made throughout the Warfare Center Enterprise.

The CPP covers investments greater than $100K and involves loans made against the revolving cash fund, which is paid back over the service life of the project. These projects mortgage the activity's future by impacting the rates customers pay for depreciation costs, so careful consideration is critical. For example, in the Ships and Ship Systems (S^3) Product Area (PA), 30-year-old exhaust stacks were replaced on Carderock Division's DDG 51 Land Based Engineering Site in Philadelphia through the CPP. Other CPP investments included acquiring a real-time virtual crane simulator for the Logistics System Simulation and Modeling Facility and procuring and installing a combined friction stir welding and friction stir processing system, both in West Bethesda.

The MILCON investments are new construction or major facility alteration projects which cost more than $1 million. These projects require Congressional approval

Below: The CPP-funded replacement of the 30-year-old exhaust stacks on the DDG 51 Land Based Engineering Site will ensure the continued verification testing of DDG and CG hull, mechanical and electrical hardware and computer programs, as well as major fleet alterations in an integrated ship systems environment for many years to come.
Photo by William Singiser, NSWC Carderock Division.

Right: Evaluation and development of cargo transfer technology can be performed in the Logistics Modeling and Simulation Facility, which was funded through the Capital Purchase Program, thereby reducing the amount of shipboard testing that is required.
Photo by Ryan Hanyok, NSWC Carderock Division.

Funded through CPP, this site is used to test friction stir welding (FSW), a novel solid state joining technology, and friction stir processing (FSP), a surface modification method.
Photo by David Meldrom, NSWC Carderock Division.

and are requested via the Navy chain of command. MILCON investments include construction of Carderock Division's Gas Turbine Test Facility in Philadelphia and the Maritime Technology Information Center in West Bethesda.

Investments are primarily hardware; however, overhead investments involving training and other discretionary overhead expenditures are also included under WCIB oversight. Overhead investments involve bid and proposal costs, consisting of systems concept formulation, engineering data development, and administrative/publication costs of proposal documentation.

Lastly, the WCIB oversees customer-funded investments in excess of $100K for facilities, as well as Independent Laboratory In-house Research and Independent Advanced Research (ILIR/IAR) Program investments. While the WCIB is not involved in approving customer-funded or ILIR/IAR projects, the data is incorporated to track where customer investments are being made. Customer-funded investments made in the S^3 PA include the construction of the Advanced Electric Ship Demonstrator sponsored by the Office of Naval Research; an upgrade to the Southeast Alaska Acoustic Measurement Facility also sponsored by NAVSEA; and development of the South Tongue of the Ocean (STOTO) Acoustic Measurement Facility sponsored by NAVSEA.

For each proposal submitted to the WCIB, a primary product area is identified, as well as secondary product areas which may benefit from the project. The PADs review the proposals and either accept or reject them. The WCIB then meets with the PADs to discuss the proposals. Finally, the investment board recommends to the Warfare Center Board of Directors what proposals should be approved. Following this cycle the board reviews lessons learned.

WCIB membership consists of two division commanding officers and two product area directors–one each from both surface and undersea. In FY 07, Charles "Randy" Reeves, the S^3 PAD, will serve as WCIB chair, having served a one-year term as a member in FY 06. Captain Mike Byman, Commanding Officer, NUWC Newport Division, will co-chair the board in FY 07. Each member serves two years. Supporting the WCIB is the Proposal Evaluation Team (PET), which collects and coordinates the divisions' investment proposals, evaluates them, and makes recommendations to the WCIB for approval or disapproval. This team is involved with all the investments except for MILCON, which is supported by a separate team. The core PET members are Sumner Baltzell from Keyport Division, Dawn Vaillancourt from Newport Division, Gloria McDonald from NAVSEA, and Brigette Murray from Carderock Division.

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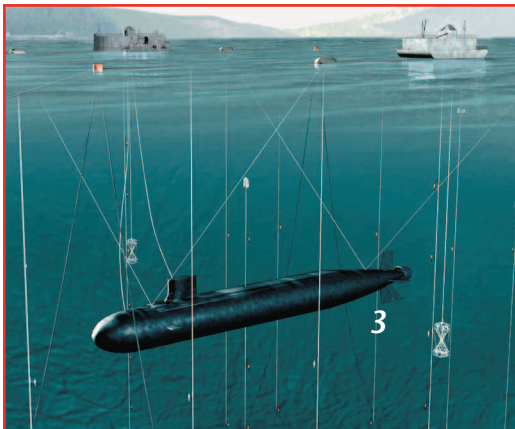
Left: Under the MILCON Program, the Gas Turbine Test Facility was constructed in Philadelphia in 2004. It consists of a 3,445-square-foot, wood-lined, 18-inch-thick, reinforced concrete test cell capable of containing fragments resulting from a catastrophic gas turbine failure or withstanding an accidental explosion of hydrogen gas resulting from a fuel cell failure.
Photo by Ian R. Amacher, NSWC Carderock Division.

Below: The Southeast Alaska Acoustic Measurement Facility (SEAFAC), operated by Carderock Division's Bremerton Detachment, provides critical signature measurements for the U.S. Navy. The facility incorporates high gain twisted bicone measurement arrays to provide the increased measurement sensitivity needed to assess the signatures of the Navy's ultra quiet *Seawolf* and *Virginia* Class submarines.
Artist rendering by Science Applications International Corporation.



S3 BUSINESS

LEAN SIX SIGMA SUCCESSES

Improving Efficiency and Effectiveness

By Pete Eobbi, Skip DiFelice, Michelle Hathaway, Marie Hussey, and Leslie Spaulding

The program for continuous process improvement within the Ships and Ship Systems (S^3) Product Area (PA) is evolving. The Carderock Division Continuous Process Improvement Office (CPIO) is placing more emphasis on the Division's 21 technical capability areas, when selecting value streams for analysis. Using Lean Six Sigma, the CPIO helps Carderock Division listen to the voice of the customer and improve key processes to deliver better value and benefit to the S^3 PA customers.

Recent examples of processes affecting the S^3 PA that were improved through Lean Six Sigma include:

Computational Fluid Dynamics Value Stream Analysis

Computational Fluid Dynamics (CFD) tools and techniques support the design, development, and validation of ship and submarine hull, appendages, and propulsors. The value stream champion believed that the escalating costs of trials and traditional model testing can be offset by the proficient application of CFD tools, so a value stream analysis (VSA) was conducted within the Hull Forms and Propulsors Core Equity to ascertain how and to what extent CFD is being used. This analysis resulted in a rapid improvement plan, with the most significant change being the centralization of the CFD capability within this core equity. Centralization provides a single point of entry for customers and consolidates expertise to effectively manage and transfer technical knowledge. The existing tool inventory will also be assessed to determine the most cost-effective approach to provide CFD analysis. A model configuration control process will also be investigated. The improvements to the current state are expected to yield $60K saving in FY 06 and approximately $175K in FY 07.

Engineering Operational Sequencing System Value Stream Analysis

This analysis focused on all facets of the Engineering Operational Sequencing System (EOSS) production process affected by information technology changes and improvements over the years. The effort aims to eliminate unnecessary manual steps or fully automate the processes. Once all the rapid improvement events are implemented, EOSS packages will be delivered to ships in a shorter timeframe.

The EOSS production process impacts approximately 400 packages per year. The process for a typical production package, accounting for approximately 75% of the EOSS packages, was reviewed. As a result of this analysis, the future state will eliminate unnecessary (non-value) steps and automate steps using available technology (software). The data entry clerks will use software to eliminate manual steps and redundant quality assurance. The engineers will be able to obtain coding information themselves without involving the data entry clerks. As a result, the future state will reduce the total number of steps from 42 to six. With the implemented efficiencies, the flow time will be reduced from 864 to 192 hours. The touch time will be reduced from 113 to 20 hours. Reducing manual steps with an automated process will, in turn, reduce the cost per package.

Fort Monroe Test and Evaluation Facility

To increase productivity at the Fort Monroe Test and Evaluation Facility in Virginia, employees working with the Continuous Process Improvement Office, performed a Lean 5S (sort, simplify, systematically clean, standardize, and sustain) procedure to streamline and clean up the workplace, implement visual controls, and put a sustainment plan in place. During a 5S, employees organize their workstations or work areas. Keeping the workplace neat, orderly, and accessible is safer and improves efficiency and productivity. This 5S event

reduced storage space 70% by getting rid of unused material, increased productivity 15% to 25% (estimated) by reducing parts search time, and improved safety by eliminating wasted motion and long reaches that were determined to be ergonomically hazardous. Since the workers themselves analyzed and rearranged their own workplace, the workers focused on how they do their jobs. The event also developed a rapid improvement mindset that is key to continuous improvement and sustainment of current changes.

Non-Conforming Products Rapid Improvement Event

Carderock Division held an event to review the process by which it handles non-conforming product (NCP) responses under the Machinery Systems Core Equity. This was done to streamline steps without compromising the quality of the final product. The team looked at types of NCPs, where they originate, how they come into the organization, and how they are handled from arrival through disposition. Through this event, the average cycle time per NCP was reduced from 69 hours to 35 by eliminating the need for NCPs, not related to SUBSAFE, to be put into the Action Route Sheet (ARS) database. Another improvement was to use electronic NCP forms instead of hardcopy, allowing for a quicker chop cycle and making them accessible to travelers who need to review. A third improvement eliminated the need for complete reviews before yellow copy, saving another 12 hours of cycle time.

The average turnaround time last year for a non-SUBSAFE NCP response from receipt to final closeout and storage was approximately 4.5 weeks. Through the implementation of the changes developed in this event, that time could be reduced to just over three weeks. Also, from receipt to initial customer response can be reduced from 11 days to five, which is more than a 50% reduction in response time per NCP. Finally, a cost avoidance of 13 manhours of touch time per NCP can be realized. With an average of 130 non-SUBSAFE NCPs per year at $90/hour, that equates to $152K in cost avoidance annually.

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CUSTOMER ADVOCACY

NAVSEA/ MULTI-PLATFORM PROGRAM CUSTOMER ADVOCACY

Making It Simple for the Complex Customer

By William Compton and Leslie Spaulding

When the Warfare Center Enterprise formalized the customer advocacy (CA) structure under product area directors, the alignment with customers was fairly straightforward in most cases. But other customers' interests were spread throughout the divisions and product areas, thus creating a need for the NAVSEA/Multi-Platform Program CA.

When the CA structure and concept was initially studied, the Ships and Ship Systems (S^3) Product Area Director (PAD) realized that 70% to 80% of the product area (PA) funding was already managed by an existing coordinator. These were fairly easy to align into a CA structure. The remaining "unaligned" funding presented a challenge. Well-structured major programs, like Interactive Multi-sensor Analysis Training (IMAT) and Machinery Alteration (MACHALT) at Carderock Division and

NAVSEA/MULTI-PLATFORM (Continued on page 6)

NAVSEA/MULTI-PLATFORM (Continued from page 5)

Underway Replenishment (UNREP) at Port Hueneme Division had clearly identified customers and product lines, which readily fit into the CA construct, but they didn't fit under a particular platform (carriers, ships, or subs). There were also projects/tasks that when pooled represented substantial funding from a specific customer. For example, the team studying customer advocacy noted that NAVSEA's Materials Engineering (05M) and Ship Survivability (05P) groups provided more than $500K in funding in FY 04 but that it was spread across the PA, with no single point of contact for the customer or the PAD. Aligning these customers to a single CA improved the clarity and the commonality for the PAD and the customer, alike.

Also, a program like the Marine Gas Turbine Program (MGT) was well aligned and focused, but other propulsion system support was fractionalized. While the technical support for these other propulsion systems was no less dedicated, the lack of focused advocacy internally and externally for propulsion systems, other than MGTs, resulted in fragmented focus and funding. Including other propulsion systems with MGT, as propulsion engineering, brought increased focus and visibility, i.e., advocacy. Finally, other efforts, such as distance support, warranted special attention because of their high visibility within NAVSEA or the Navy overall.

A common thread throughout this CA area is the variety of sponsorship. NAVSEA/Multi-Platform Programs typically draw funding from various sources, so balancing needs and focus is important to the CAs. This can be seen from this overall list of the programs covered by the individual CAs and the customers for each:

Cross Platform Engineering and Alteration Programs

Top management attention includes engineering for reduced maintenance, capital investments for labor, and reduction of total ownership costs (SEA 05N and Commander U.S. Fleet Forces Command (CFFC) via SEA 05N); MACHALT (OPNAV via SEA 05Z); systems engineering technical authority funding (SEA 05N); technical authority funding for specifications and standards (SEA 05Q via SEA 05N); Technology Insertion Program for Savings (ONR with SEA 05N as fleet integrator); McConnell Technology Transition Center (WFPP with SEA 05N as fleet integrator); and Maintenance Figure of Merit (CFFC via SEA 05N).

Interactive Multi-sensor Analysis Training (IMAT) and Associated Programs

This includes supporting the IMAT Mobile Training Team and software upgrades for the Fleet Anti-Submarine Warfare (ASW) Command; IMAT Air ASW software maintenance and curricula for NAVAIRSYSCOM; and IMAT research and development for the Office of Naval Research. This CA also supports the Common Operator Analysis and Employment Training, the Submarine Multimission Team Training Phase 3 (SMMTT3), the Acoustic Analysis Trainer, the Sonar Employment Trainer, the Naval Submarine School Support, the Virginia Class SMMTT3–all for NAVSEA; the Periscope Signature Imagery for NUWC; and the All World Environment Simulation for the Office of Naval Intelligence. Also supported are NAVSEA's Sonar Tactical Decision Aid (STDA), Sonar Performance Prediction Functional Segment-STDA, Undersea Warfare Decision Support System, STDA-MEDAL, and STDA-Integrated Undersea Surveillance System; SPAWAR's Scalable Tactical Acoustic Propagation Loss Engine; and NUWC's STDA LCS.

Distance Support and Networks

This involves distance support training execution and distance support maintenance and logistics development (SEA 03D). It also includes Integrated Condition Assessment System program of record; hull, mechanical and electrical (HM&E) wireless integration efforts; HM&E video monitoring and integration; advanced machinery control technology insertion; and remote monitoring for HM&E systems (all SEA 05Z and fleet).

Integrated Logistics Support

This CA handles logistic technical data (Engineering Operational Sequencing System, Planned Maintenance System, technical manuals, shipboard instrumentation and system calibration, allowance parts lists, coordinated shipboard allowance lists, etc.) (SEA 04); training (SEA 03); certification/verification testing

NAVSEA/MULTI-PLATFORM (Continued on page 8)

The common thread throughout the NAVSEA/Multi-Platform Program Customer Advocate is a wide variety of sponsorship and support. The collage (opposite) shows the myriad support/customers that fall within the purview of this CA. *U.S. Navy Photos.*

NAVSEA/MULTI-PLATFORM (Continued from page 6)

of Navy Stock System items such as paints and adhesives and repair depots for submarine sail systems and oil content monitor rotatable pools (NAVICP); and Navy representative for joint computer-aided acquisition and Information and Control System (NAVSUP).

Propulsion System Programs

Support of the MGT Program involves providing ready-for-issue marine gas turbines to the fleet; repairing non-ready-for-issue units; developing and testing reliability improvements; tracking reliability and performance metrics; procuring modification kits; and tracking configurations (all SEA 05Z). The propulsion (diesel and boiler) program support includes providing in-service engineering agent/ life cycle management support by developing maintenance procedures; developing and implementing non-intrusive distance support techniques to define maintenance repair packages; coordinating inspector programs; and maintaining websites (all SEA 05Z).

Structures, Survivability, Material and Environmental

This CA supports programs in materials and environmental (SEA 05M); structures, survivability, damage control, and firefighting; and chemical, biological, and radiological defense (SEA 05P). It also supports reconnaissance, surveillance, and targeting vehicle testing; hydrodynamic engineering and development test support of the expeditionary fighting vehicle; certification of lithium batteries; air combat element impact study on large deck amphibious ships; Joint Service Transportable of Decontamination Systems Program; and high mobility artillery rocket system shipboard shock testing (all United States Marine Corps).

Underway Replenishment

The Fleet Support Program provides life-cycle maintenance technical assistance for all combat logistics force ships and other surface ships (MSC and fleet). The Machinery Systems Support Program includes the DDG 1000 (UNREP system (SEA 05D); T-AKE UNREP system (PMS 325); CVN 26 heavy UNREP receiving system (PMS 378); and heavy UNREP delivery system research, development, test and evaluation (OPNAV N42 and PMS 325).

Additionally, the NAVSEA/Multi-Platform CAs are one of only two groups who have advocates on-site with the customers in the fleet and at OPNAV N40.

Why not align funding by major customer to keep everything neat and tidy? Although it's easy to conceptually "package" projects/tasks to a single major customer (e.g., NAVSEA 05Z to one CA), that does not always best represent the customer. When customers identify with a major program, such as IMAT or MGT, they want the sense of alignment and advocacy within the PA. One of the principle roles of the CA group is to deeply understand the customers' needs and advocate on their behalf within the Warfare Center.

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SHIP INTEGRATION & DESIGN

SHIP INTEGRATION AND DESIGN FACILITIES

Teaming on Waterfront Enhances Investment in Combatant Craft Research

By William Palmer

The Combatant Craft Division (CCD) of the Naval Surface Warfare Center, Carderock Division, in Norfolk, VA, operates and maintains two waterfront facilities, which are used to support the warfighter during test and evaluation, systems integration, in-service engineering, and alteration installation on manned and unmanned craft. CCD's primary waterfront facility, the Combatant Craft Division Waterfront Operations Facility, is at Fort Monroe, VA, and includes work bays with overhead cranes, machine shop, and dock space. Specialized test equipment for the measurement of force, torque, pressure, temperature, speed, and position is maintained at the Fort Monroe facility along with machines for calibrating load cells and torque transducers. A small inventory of boats for the purpose of test range safety and security, photographic platforms, science and technology (S&T)/research and development (R&D) experimentation, and the evaluation of boat modifications and new technologies is maintained at this facility. The Chesapeake Bay region gives access to different marine environments, such as open ocean, littorals, surf zones, harbors, and rivers. Although it is an older facility (building 204 is on the historical register), CCD test and evaluation (T&E) engineers have made do with minimal investment in the facility, while still satisfying the needs of their various customers. Planning is underway to relocate the activites at Ft. Monroe to a replacement site at Norfolk Naval Base, which consists of a large building with high bays and waterfront access.

Combatant Craft Division Waterfront Operations Facility, Ft Monroe.
U.S. Navy Photo.

Trials are conducted on new craft at builders' facilities around the United States and throughout the world, but a great deal of testing is executed from the Fort Monroe facility. Measurements conducted run the gamut of speed, performance, and technology and can be as simple as the weight of the craft, or as complex as torsional vibration and sound intensity testing. Testing of diesel-powered, conventional-drive Navy utility boats, once a mainstay of the Division, has given way to research and development of high-speed technically advanced craft like the Special Warfare Command's *Mark V* Special Operations Craft (SOC) and the 170-foot Patrol Coastal (PC).

SHIP INTEGRATION (Continued on page 10)

U.S. Navy Seals aboard a rigid hull inflatable boat during training for Operation "Enduring Freedom."
U.S. Navy photo.

SHIP INTEGRATION (Continued from page 9)

A second facility, the Advanced Maritime Technology Center (AMTC), is located at Patuxent River Naval Air Station in Patuxent River, MD. The Advanced Maritime Technology Center is a joint initiative between Naval Air Systems Command (NAVAIR) and NAVSEA designed to facilitate joint experimentation and integration of aircraft technologies to watercraft. The AMTC is ideally suited for the evaluation of mechanical, electrical, and communications systems on watercraft; conduct of propulsion and maneuvering trials on high-performance craft; signatures testing on a variety of novel hull forms; and evaluation of unmanned aerial vehicles from marine craft. The CCD and Naval Air Warfare Center are collaborating at this site to leverage efforts to integrate aviation and marine vehicle technologies. This work in high-tech areas will contribute to the improved operation of unmanned Navy platforms. A memorandum of understanding is being developed to transfer ownership of the facility to NAVAIR. This will reduce operating costs paid by the Carderock Division for use of AMTC starting in FY 07 when the Carderock Division will reimburse NAVAIR on a project-by-project basis instead of bearing all the operating costs for the AMTC.

The origins of the CCD as an organization and its testing and evaluation capabilities and facilities go hand in hand. The Navy's design function for boats and small craft was located in Washington, DC, until the summer of 1967, when the Boat Engineering Center composed of the Boat Design Branch in Washington with the addition of a test group, was established in Norfolk, VA. The design and test personnel were located "dockside" in the Amphibious Maintenance Support Unit until the fall of 1969, at which time the department was relocated in the Naval Ship Engineering Center, Norfolk Division's new headquarters. The CCD's primary offices are currently located on the Naval Amphibious Base in Norfolk. The Norfolk location has served the organization well, as it is in proximity to the fleet, permitting testing and evaluation of the boat designs that were being created and then testing and validation of the products that were

The *Cyclone*-class coastal patrol ship *USS Typhoon* (PC 5) patrols the waters of the Persian Gulf.
U.S. Navy photo.

Naval Special Warfare combatant-craft crews operate a rigid hull inflatable boat (right) and *Mark V* Special Operations Craft (left).
U.S. Navy photo.

Security Force Protection teams, assigned to Naval Support Activity (NSA), Bahrain, stand watch as Sailors and Marines assigned to the *Nimitz*-Class aircraft carrier *USS Harry S. Truman* (CVN 75) enjoy liberty.
U.S. Navy photo.

actually built. The waterfront facilities of the CCD are vital to the craft systems engineering needs of the Navy and other DoD agencies.

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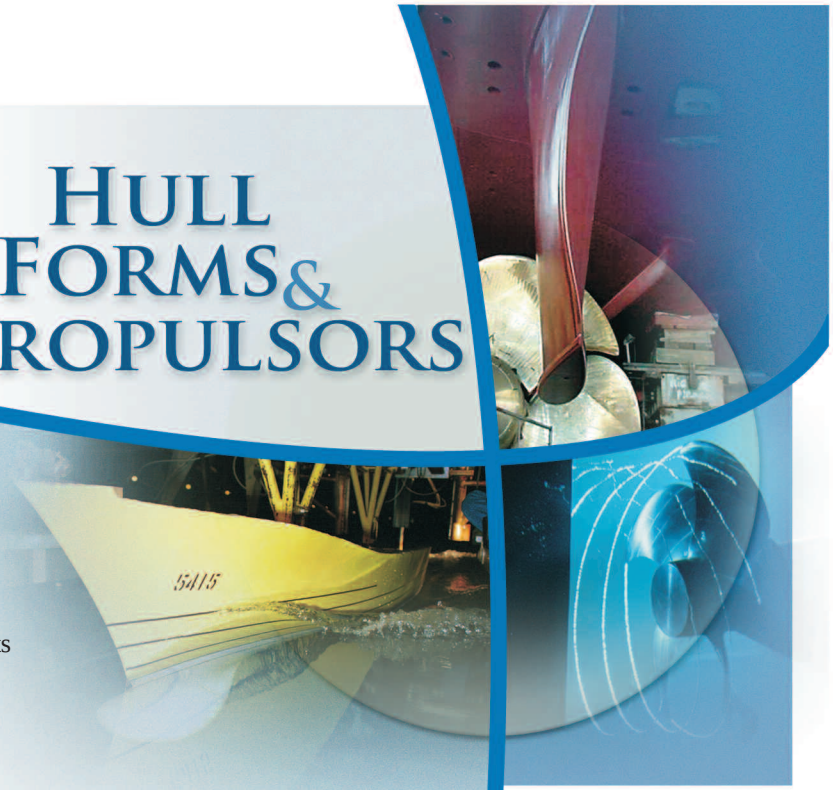
HYDRODYNAMIC FACILITIES

HULL FORMS & PROPULSORS

Moving the Latest Ship Designs to the Fleet



By William Palmer

The U.S. Navy is continually investigating a variety of advanced concepts and new technologies in hull forms and propulsors to enable it to meet new and evolving mission requirements in a resource-constrained environment. A key to introducing such improvements into the fleet via the acquisition process, for both new design and back-fit, is providing assurance to program managers that these concepts

HYDRODYNAMIC FACILITIES (Continued on page 12)

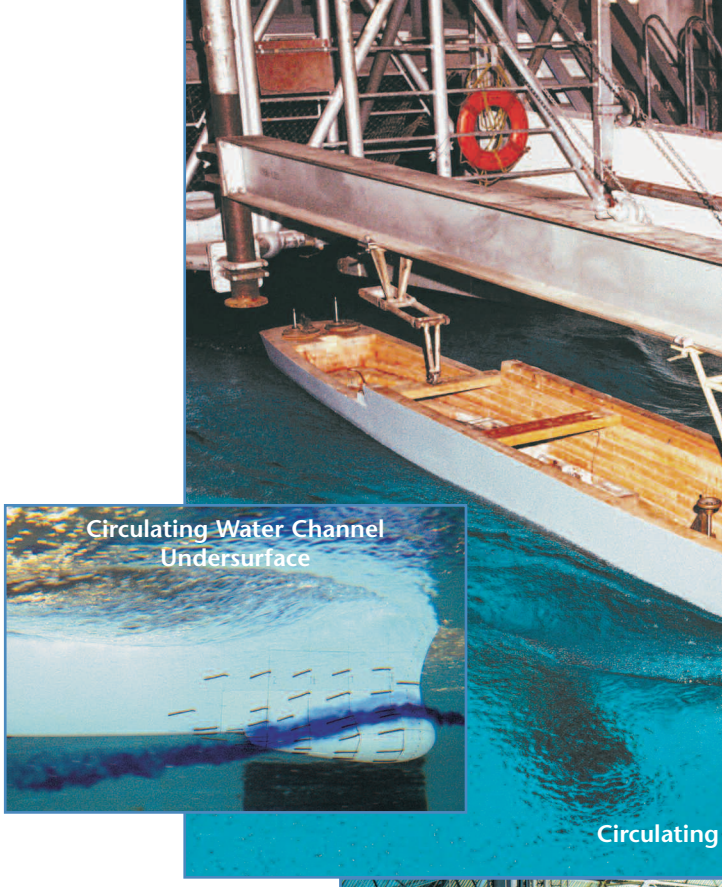
HYDRODYNAMIC FACILITIES (Continued from page 11)

work “as advertised.” That is, they are in fact, capable of producing the performance claimed with acceptable risk and at acceptable cost. In many cases where a full-scale demonstration is not feasible or cost effective, the Navy carries out model-scale tests. Accurate model tests can provide the risk reduction and performance assurance necessary to move forward with new designs.

The Carderock Division, Naval Surface Warfare Center operates a large complex of model basins, towing carriages, a circulating water channel, and cavitation water tunnels to satisfy a wide variety of hydrodynamic experimental requirements. Technical ship design support is furnished to the Navy and other government agencies, as well as to private ship design and maritime organizations. This support includes both experimental and analytical programs related to every type of ship and craft, including platform, mooring and towed systems. Recent and ongoing Navy programs, which supported utilizing the capabilities of these facilities include the DDG 1000, the LCS, *SeaFighter*, *Seawolf*, and *Virginia*. Work for the DDG 1000, for example, has been carried out in the David Taylor Model Basins–resistance, powering, propulsor inflow; in the 36-inch Water Tunnel–propulsor performance; in the Maneuvering and Seakeeping (MASK) Basin–motions and loads in waves; and in the Rotating Arm Facility–maneuvering performance.

All facilities are located in West Bethesda, MD, with the exception of the Large Cavitation Channel (LCC), which is located on President’s Island in Memphis, TN. The David Taylor Model Basin building is 3,200 feet long and houses the three long basins. The 140-foot basin, located in another building, is used for small-scale experiments. The Harold E. Saunders Maneuvering and Seakeeping Facility houses five acres under one roof and contains the Rotating Arm Basin and the large MASK, which among other features, has a wavemaking capability. These are all considered important national assets. The David Taylor Model Basin is among the largest of its kind in the world. Using its sophisticated combination of towing carriages, wavemakers, and measuring equipment, engineers can determine the seakeeping qualities and propulsion characteristics of ship and craft models up to 40 feet long. The facility has provided key support in the development of naval architecture for the Navy, Coast Guard, Maritime Administration, and maritime industry.

The Circulating Water Channel is used for flow visualization experiments on ship hulls, rudders, fairings, struts, bilge keels, and other appendages, including studies of stack gas flow over ship superstructures at various



Hydrodynamic Facilities at the Carderock Division.
Photos by NSWC Carderock Division Photographers.

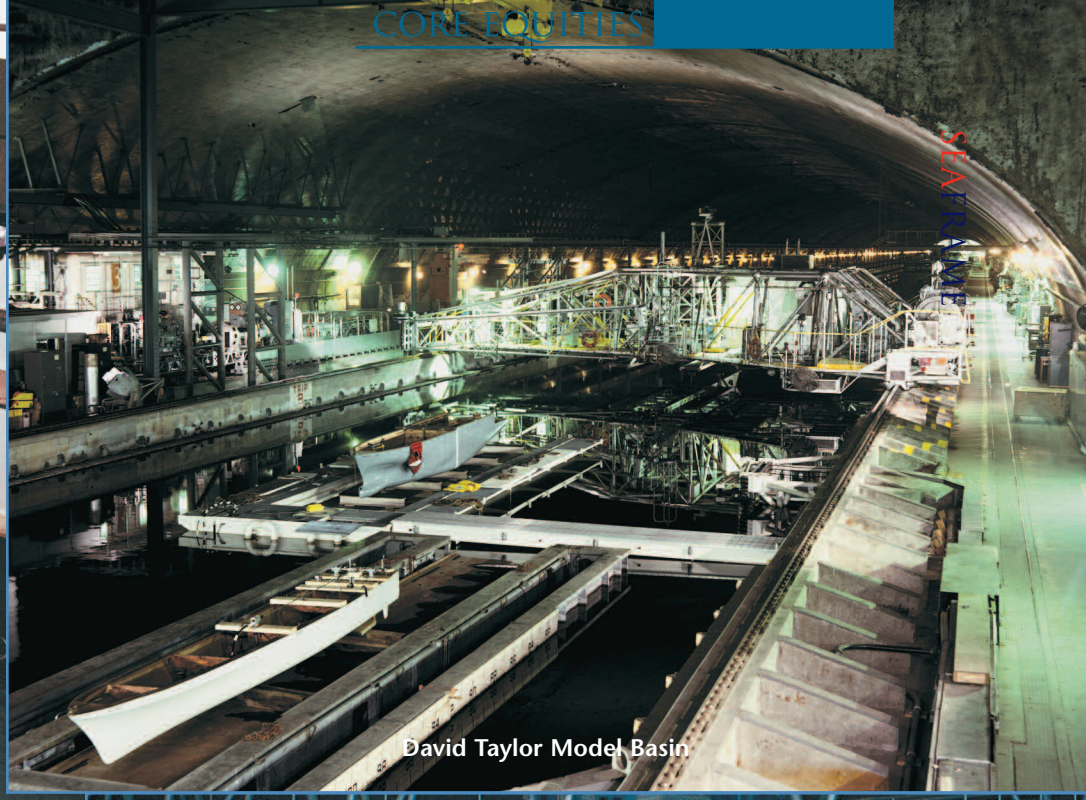
headings and towed body evaluations. A model is held stationary in the channel, while water flows around it at various speeds. Strips of yarn or dye, and other instrumentation, show the flow patterns, which can be recorded, observed and photographed through underwater windows.

The Division has several variable pressure cavitation channels. At West Bethesda, the water tunnels are used primarily to determine the performance and cavitation inception characteristics of propellers and ship appendages.

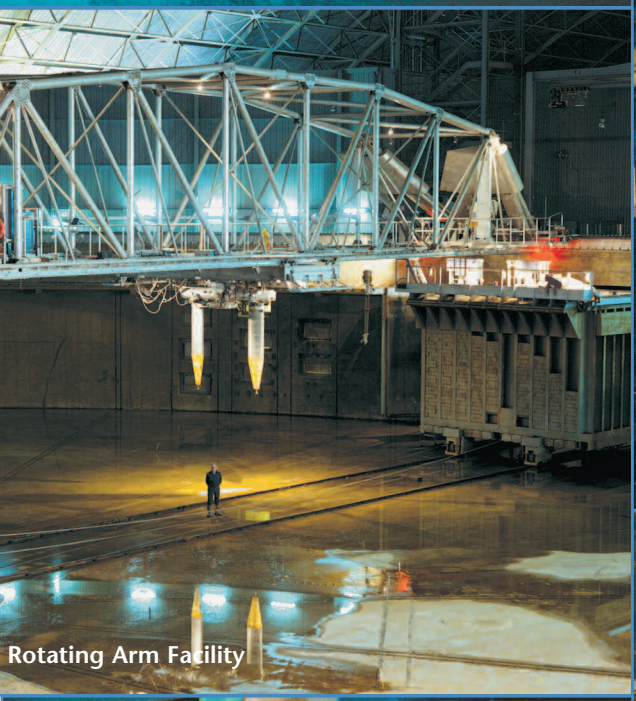
At the Division’s Memphis detachment, the LCC tests the propulsor power, efficiency, and acoustics of large-scale models of ships and submarines in a controlled environment. The LCC is 236 feet long and 65 feet high. The test section measures 10 feet square in cross section and can hold models up to 40 feet long.

HYDRODYNAMIC FACILITIES (Continued on page 14)

Water Channel



David Taylor Model Basin



Rotating Arm Facility

Wavemaking Facility

Propeller cavitating in the LCC

Maneuvering and Seakeeping Facility

HYDRODYNAMIC FACILITIES (Continued from page 12)

The David Taylor Model Basin Facility contains a Shallow Water Basin and a Deep Water Basin. An arched, reinforced concrete roof with a span of 110 feet encloses the building. Towing carriages run along rails that follow the curvature of the Earth's surface. As a result, the distance of the model from the water surface is constant, regardless of its position on the track. The tops of the rails lie concentric with the still water surface throughout the length of the basins. The rail foundations rest upon bedrock. The towing carriages are powered by either electric or electrohydraulic drive systems with regenerative braking action. Each is equipped with model motor power supplies, force measuring dynamometry, data acquisition systems, and photographic lights.

Wavemakers in the High Speed and Deep Water Basins produce head and following waves. Equipment allows engineers to determine the seakeeping qualities and propulsion characteristics of models in either uniform or irregular waves. The Shallow Water Basin's water level can be varied to simulate rivers, canals, and restricted channels.

The MASK is used to predict the full-scale performance of ships, platforms, and mooring systems in realistic waves, which can simulate the ocean up to sea state 9. In this facility, engineers evaluate the maneuverability, stability, and control of surface ships and submarines in waves and smooth water.

A bridge spans the MASK lengthwise. A rail system permits the bridge to traverse one half the width of the basin and to rotate through the angles up to 45 degrees from the longitudinal centerline. This allows models to be towed in either head or following seas at any angle. Tracks attached to the bottom of the bridge support a towing carriage that carries test personnel, instrumentation, and carriage control equipment.

Two banks of pneumatic wavemakers on adjacent sides of the basin generate either regular or irregular long- and short-crested waves programmed by computer. Wave absorber beaches, constructed from sloping precast concrete bar panels, quiet the water surface between test runs. They are located opposite the wavemakers.

The Rotating Arm Facility is a 260-foot diameter circular basin with a rotating arm. The arm pivots about a center post and tows models in circular paths. Located beneath the arm structure is a carriage, which can be moved radially on tracks. Model towing struts and positioning apparatus can be attached to the carriage. This facility is used primarily for captive model maneuvering stability and control experiments.

The results of testing in these facilities have enabled the U.S. Navy to introduce many technological advances into the fleet over the past 100 years. Many new technologies being tested today will find their place in the fleet of tomorrow. As these facilities are maintained and upgraded, they will continue their crucial mission far into the future, enabling the Navy After Next.

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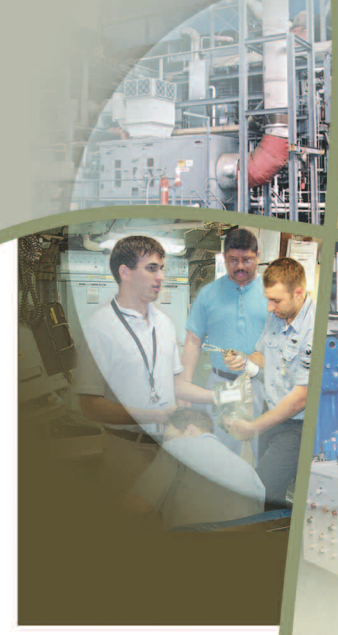


MACHINERY SYSTEMS

MACHINERY RESEARCH AND ENGINEERING

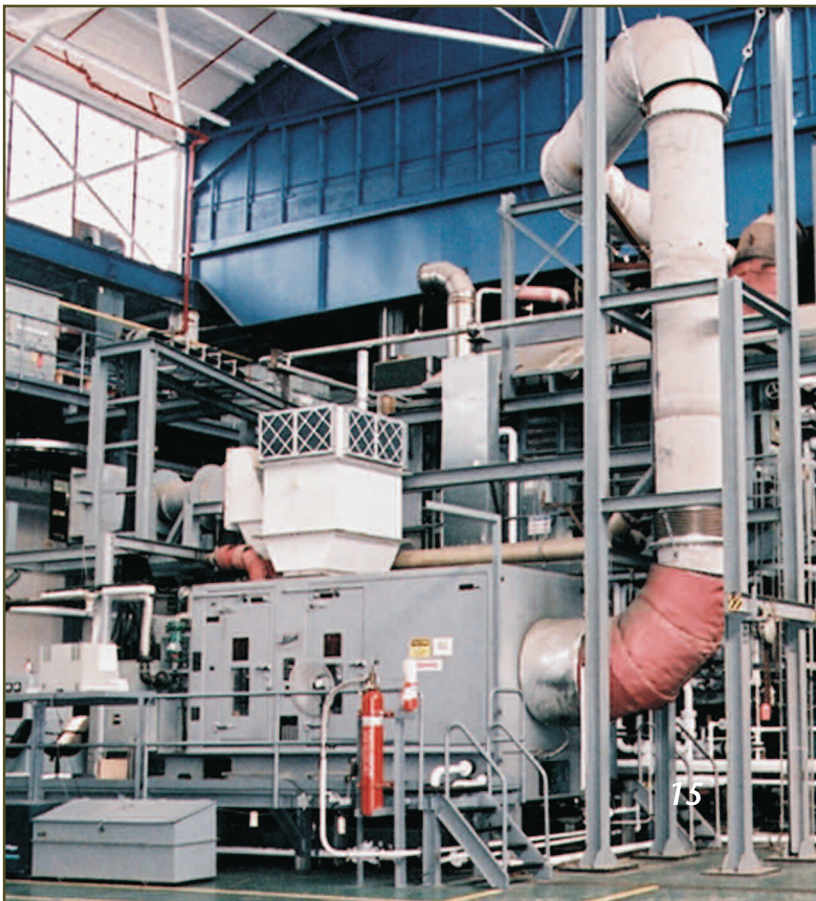
Land-Based Testing Enhances Reliability, Affordability, and Effectiveness and Enables Innovation

By Leslie Spaulding

Whether developing futuristic concepts for the Navy After Next or resolving deckplate problems in today's fleet, engineers supporting the Ships and Ship Systems (S^3) Product Area (PA) rely heavily on the knowledge gained through land-based testing. The support provided under the Machinery Systems Core Equity covers the full life cycle of machinery. It begins at the earliest stages of technology development, continues through research and development to new ship construction, and flows into in-service engineering support to ships and ship systems currently in the fleet. S^3 engineers develop, maintain, and use world-class testing facilities to develop the concepts, technologies, equipment, systems, and procedures current Navy ships need to operate reliably and affordably and to effectively meet performance and mission requirements, as well as conceive and test innovations for the future.

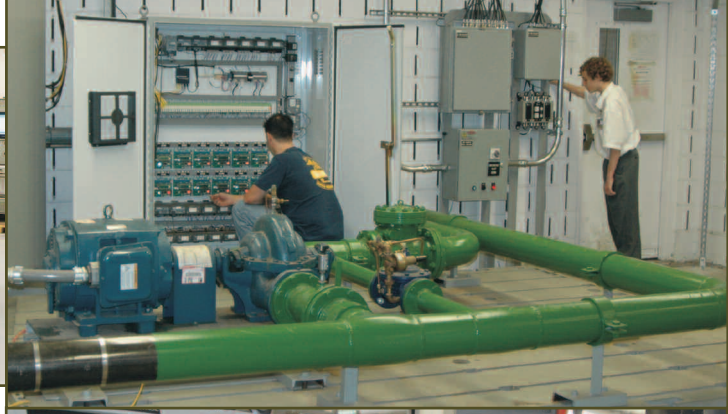
Land-based testing offers many benefits. It allows for the most realistic integrated testing of shipboard engineering. Shipboard integrated testing impacts schedules heavily. Through land-based testing, individual machinery issues can be addressed and resolved so underway testing can focus on ship-wide operation. Additionally, such land-based tests can be run for long periods to address engineering issues–spending several hours in a certain condition to study or gain information about design or integration issues. This is difficult to do shipboard given ship commitments and obligations and is usually cost prohibitive. Also, land-based testing can be used to test iterations of designs and prototypes before installing them shipboard to minimize problems and allow for shipboard integration with little impact on a ship's schedule. Finally, land-based testing can far more easily test extreme conditions, up to and in excess of design thresholds, more safely.

MACHINERY RESEARCH (Continued on page 16)



The DDG 51 Land Based Engineering Site provides integrated testing, computer program verification, and program risk reduction of machinery controls, electrical plant controls, mission critical networks, integrated bridge systems, and other auxiliary/support systems.
Photo by Pam Lama, NSWC Carderock Division.

Right: The PEO Ships Networking Lab is used to test and evaluate current and future shipboard network architectures. *Photo by Larry Hawkes, NSWC Carderock Division.*



Middle right: Mark Cybulski and Rick Breitenstine run damage scenarios based on DDG 51 Class chilled water systems in the Chilled Water System Automation Test Facility. *Photo by Martin Sheehan, NSWC Carderock Division.*

MACHINERY RESEARCH (Continued from page 15)

The following are unique facilities contributing to machinery research and engineering:

DDG 51 Land Based Engineering Site

This site in Philadelphia provides integrated testing, computer program verification, and program risk reduction of machinery controls, electrical plant controls, mission-critical networks, integrated bridge systems, and other auxiliary/support systems such as the integrated condition assessment system (ICAS), the chilled water automation system (CWAS), the fuel control system (FCS), and damage control (DC) systems that are employed onboard all flights of the DDG 51 Class and CG 47 Class vessels equipped with the Smartship upgrade. This test facility is used quite extensively to demonstrate interoperability of all these control systems with main propulsion gas turbine engines, a propulsion train, ship service gas turbine generators, various auxiliary equipment, and distributed navigation users communicating over the same network. In addition to testing, the command continues to receive excellent feedback for the site in its usage for training of pre-commissioning units, Surface Warfare Office School prospective chief engineers, and advanced engineering and miscellaneous fleet train/trainer courses. The DDG 51 Land Based Engineering Site (LBES) features two LM 2500 propulsion gas turbine modules, three ship service gas turbine generators, each equipped with a full-authority digital controller (FADC), machinery control system suites for all flights of DDGs and CG Smartship, electric plant switchgear and protective devices for Flight IIA and multi-year DDGs, integrated bridge system/scalable IBS (IBS/SIBS) for all DDG and CG ships, ICAS, damage control suites for CG/DDG, and newly automated support systems such as CWAS and FCS. In addition to supporting the U.S. Navy, this site is used by academia for training, design projects, and demonstration and by private industry and ONR for proof of concept testing of new systems and independent research.

DDG 51 LBES Site Manager,
Andy Cairns..... 215-897-7446 (DSN 443)

Above: Tom Liolios operates the Integrated Fight Through Power Test Site from the control room. *Photo by Martin Sheehan, NSWC Carderock Division.*

Chilled Water Automation System Test Facility

The Chilled Water Automation Systems (CWAS) is an automated damage control system that employs distributed device level control to ensure that chilled water is maintained to the critical air warfare components in the event of damage to the chilled water system. This Philadelphia facility is a full-scale, reduced-scope demonstrator to verify the damage detection, isolation, and reconfiguration capabilities. The loop approximates the port chilled water loop on a DDG 51 Class platform with complete CWAS distributed network with Fiber Optics Data Multiplex System backbone. The site is currently poised for implementing the CWAS system, as well as future distributed systems modernization efforts.

Site Manager,
Edward McCunney..... 215-897-7230 (DSN 443)

Carderock Division engineers Maria Donnelly and Joe Jacobs monitor the land-based test sites supporting DDG 1000 using the Test Operations and Analysis Center (TOAC). The huge channel capacity needed by this test required TOAC engineers to design, manufacture, and integrate in house the largest data acquisition system ever built using TOAC.
Photo by Martin Sheehan, NSWC Carderock Division.

PEO Ships Networking Lab

The only Navy lab of its kind, this Philadelphia site is used to test and evaluate current and future shipboard network architectures, including core network design and user system interfaces. It is used for the receipt, testing, and operational verification of the Fiber Optic Data Multiplex System (FODMS) network maintenance group computer racks for the DDG 51 Class prior to delivery to the shipbuilder. It also supports DDG Modernization network development and testing efforts and permits life-cycle support of all shipboard network equipment.

Site Manager,
Steve Walicki..... 215-897-8753 (DSN 443)

Integrated Fight Through Power Test Site

This Philadelphia site is used to test and evaluate electronic-based power converters and the DC zonal architecture known as Integrated Fight Through Power (IFTP). It is also being used for electrical loading of DD(X) Integrated Power System Engineering Design Module (IPS EDM) Land Based Test Site (LBTS) generators. The IFTP Test Site is the only Navy facility dedicated to testing and evaluating IFTP. It is unique in that real shipboard type loads are available and integration with the DD(X) IPS EDM LBTS allows for total integrated power system test and evaluation. The site is also being used to support Bath Iron Works in DDG 1000 low voltage system design.

Site Manager,
Matt Stauffer..... 215-897-8407 (DSN 443)

Sumit Dutta prepares to perform software testing on the LHD Improved Fuel Fill Control System at the Auxiliary System Automation Test Facility.
Photo by Martin Sheehan, NSWC Carderock Division.

Test Operations and Analysis Center (TOAC)

Located in Philadelphia, PA, this facility is used to design, develop, fabricate, and integrate data acquisition systems for use shipboard and at land-based test and engineering sites. It serves as a centralized, computer-controlled data acquisition center for other test sites in the building, which are connected via fiber optic cable. The TOAC also houses Carderock Division's shipboard and land-based test/engineering site data for long-term storage, archiving and security, which allows for both local and remote access to the data. By providing real-time, on-line data, TOAC eliminates the need for test engineers to wait for calculations and analysis.

With its capacity for large-scale data acquisition system fabrication/integration and long-term, secure data archiving and retrieval, the TOAC is a great asset to the Navy. The center is also used by private industry partners, such as Northrop Grumman, Anteon, and Amsec, in support of Navy programs.

Site Manager,
Maria Donnelly..... 215-897-7473 (DSN 443)

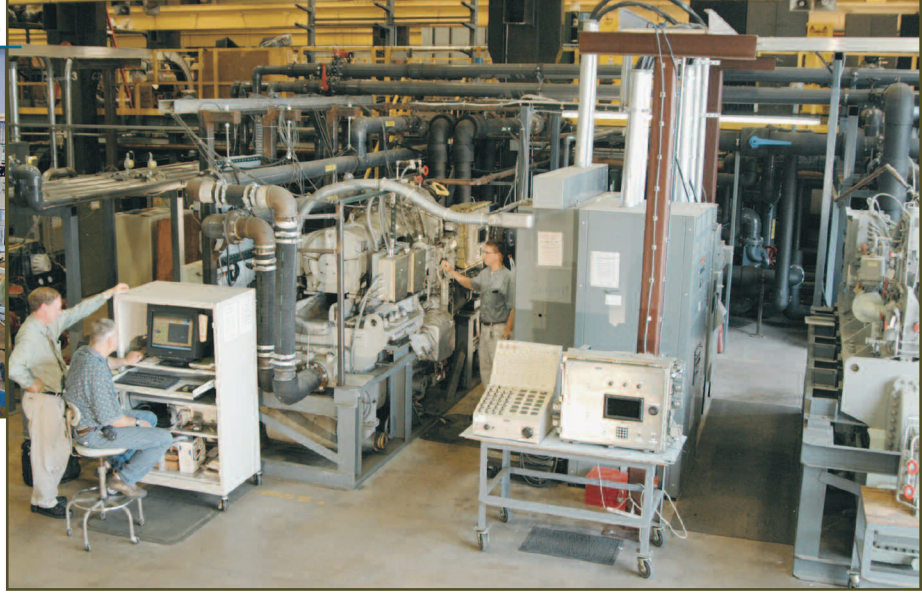
Gas Turbine Test Facility

Located in Philadelphia, this site was designed to handle large gas turbine engine testing up to 35,000 horsepower. Its unique features include an isolated control room for possible module-free engine testing; an inter-changeable "t-block" mounting deck; an overhead 50-ton bridge crane; plumbed support systems for fuel oil, river cooling water, city water, and compressed air; and a test cell ventilation system. In addition to supporting the U.S. Navy, this facility has been used by private industry with government cooperation through a work for private parties agreement. Currently, there are two capital purchase program projects underway at the site to add a gas turbine digital engine controller and a gas turbine control and data acquisition system.

Site Manager,
Eric McFetridge..... 215-897-8707 (DSN 443)

MACHINERY RESEARCH (Continued on page 18)

The Communications and Control Lab is used to certify, modify, and repair submarine antennas and related components.
Photo provided by James Stiles, NSWC Carderock Division.



Engineers monitor testing at the Air Conditioning and Refrigeration RDT&E Facility.
Photo by Martin Sheehan, NSWC Carderock Division.

MACHINERY RESEARCH (Continued from page 17)

Fuel Cell Lab

This Philadelphia laboratory is used to develop, test, and evaluate fuel cells and associated equipment for Navy surface and undersea applications. This is a state-of-the-art laboratory devoted to testing and evaluating fuel cell power plants for naval surface and undersea applications. It is designed to test up to 2.5 megawatts of power generated from fuel cells, with interconnection to nearby electrical or mechanical laboratories to form an integrated system. In addition to Navy work, the lab is used by private industry and academia.

Site Management,
Mark Cervi.....215-897-7068 (DSN 443)

Multipurpose Integration Facility/Smart Carrier Integration Facility

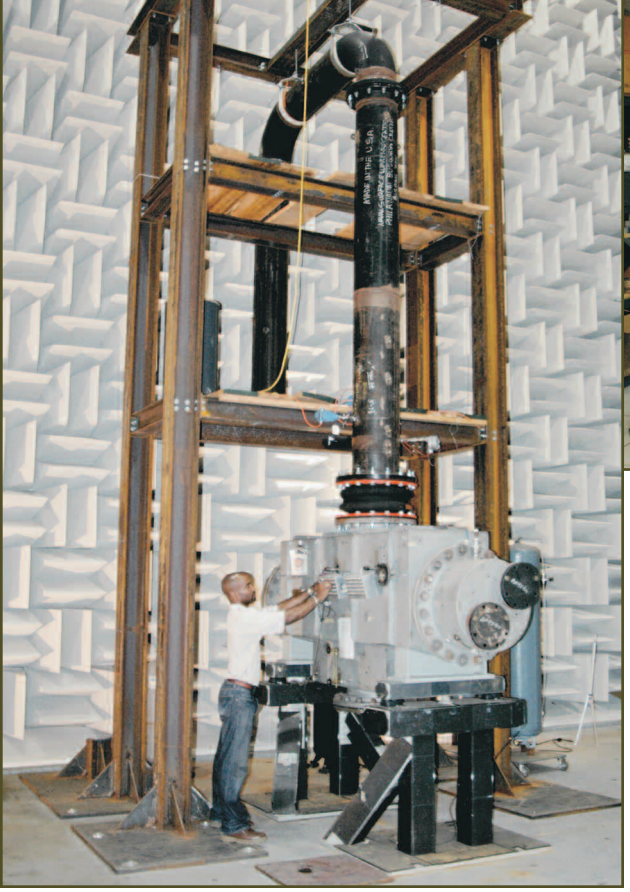
This Philadelphia facility is used to develop, integrate, and test the CVN 68 machinery control system, navigation control and data system, and core network. The facility also integrates with other applications such as the integration condition assessment system, the advanced damage control system, the flooding casualty control system, and fuels management software. The Multipurpose Integration Facility (MPIF)/Smart Carrier Integration Facility contains equipment that can be reconfigured to represent each of the CVN 68 Class unique control and monitoring systems. The equipment is also used to prototype and develop possible software and hardware for shipboard use. In addition to testing, the site is used for training ship's force to use the control systems. The Smart Carrier part of the site has completed an equipment upgrade to support testing of the expanded CVN 60 MCS. The MPIF portion is undergoing an equipment expansion to support delivery for the CVN 77 in FY 08.

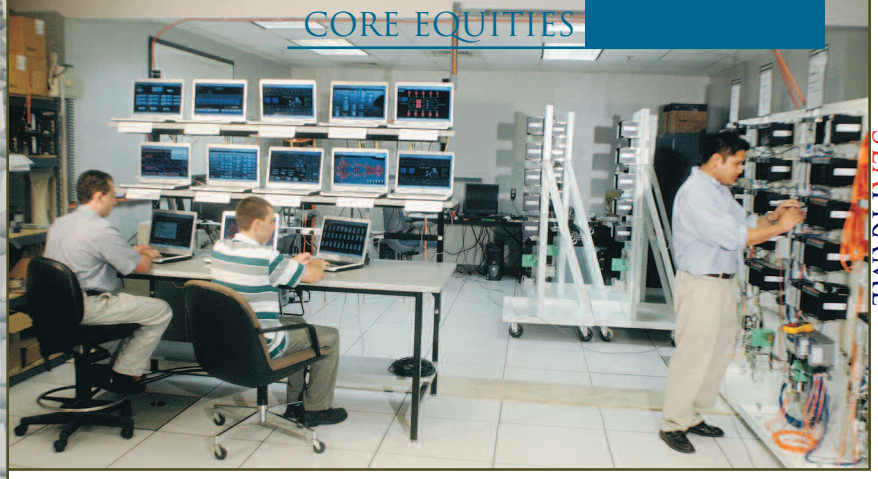
Site Manager,
Jeffrey Cohen.....215-897-7149 (DSN 443)

Communications and Control Lab

Located in Philadelphia, this site is used to certify, modify, and repair submarine antennas and components, and this consortium of multiple submarine antenna test set labs is outfitted with special-purpose, customized test equipment. The lab is used for in-service engineering support across all submarine classes for the OE 538, OE 207, OE 562, and BRA 34 antennas. The Communications and Control Lab also supports the Radio Frequency Distribution and Control System (RFDACS) for the common radio room on the SSN 21, SSGN, and SSGN 774 Class submarines. Used for virtual submarine sail modeling, the lab offers 3-D CAD modeling of the submarine sail superstructure with integrated internal antenna systems. The sail system models for SSN 688, SSGN 726, SSBN 726, SSN 21, and SSN 774 Classes are used to improve, expand, and expedite sail hull, mechanical, and electrical engineering analyses, engineering change proposals, presentations, and future initiatives.

Site Manager,
James Stiles.....215-897-1703 (DSN 443)





Top: Engineer Michael Tran and students Stu McDonald and Joe Springer at the Smart Carrier site.
Photo by Martin Sheehan, NSWC Carderock Division.

Left: Carderock Division engineer Glen Bell attaches sensors to a test component to collect data in the Anechoic Chamber, which is part of the Machinery Acoustic Silencing Complex.
Photo by Martin Sheehan, NSWC Carderock Division.

Auxiliary System Automation Test Facility

Located in Philadelphia, this is the Navy's only facility to support the Improved Fuel Fill Control System (IFFCS) current/future installations on the LHA, LHD, and DDG Classes. The facility is used for IFFCS development, testing, and training. This site supports development of a new IFFCS system for LHD Class ships, which is scheduled to begin in FY 07. The site also supports the existing systems on LHA Class ships. Additionally, the site will be used for new construction and backfit IFFCS systems currently installed as forward-fit and back-fit on DDG Class ships. The fluid system loop portion of the IFFCS test loop will be used to test component level upgrades for auxiliary fluid systems piping and components.

Site Manager,
Joseph McGillian.....215-897-7705 (DSN 443)

Machinery Acoustic Silencing Complex

This Philadelphia complex is a 40,000-square-foot facility encompassing three separate full-scale machinery acoustic test areas that include a 2,500-square-foot anechoic chamber, a 7,500 square-foot quiet machinery test cell, and a 35,000-gallon high flow acoustic test facility. The measurement capability of each of these facilities coupled with a large floor load capacity (100 tons maximum), a low-noise water cooling system, and a low-noise electrical supply system make these facilities unique and an important asset to the Navy's mission. The anechoic chamber can measure airborne noise levels down to 25 Hz. Both the anechoic chamber and the quiet machinery test cell are used to conduct full-scale acoustic evaluations to determine the airborne, structureborne, and fluidborne noise transmission paths for both surface ship and submarine machinery components. Both the anechoic chamber and the quiet machinery test cell are also used for various other purposes, including performing static and dynamic characterizations of vibration and shock isolation devices, performing developmental testing of small-scale structures, developing microbalancing software and data acquisitions, simulated testing of submarine systems, modal testing for carriers, and housing a central machinery vibration database for 17 ship classes.

Site Manager,
Mike Grady.....215-897-8917 (DSN 443)

Air Conditioning and Refrigeration Research and Engineering Test Facility

As the Navy's only comprehensive facility for research, development, test and evaluation of Air Conditioning and Refrigeration machinery, this site is capable of conducting full-scale systems and component

MACHINERY RESEARCH (Continued on page 20)

A mockup of the fueling station to be used aboard DDG 1000.
Photo provided by NSWC Port Hueneme Division.

MACHINERY RESEARCH (Continued from page 19)

testing on air conditioning and refrigeration equipment to accommodate emergent fleet needs, littoral operations simulations, and future ship design development. It is capable of testing AC plants from various ship classes up to 800 tons of cooling capacity. The five independently controlled test cells at the site currently simulate conditions from the North Atlantic to the Persian Gulf. The Philadelphia facility is also equipped with a comprehensive refrigeration test capability designed to support condensing units ranging from 1 to 2 tons of cooling capacity. Test work includes reliability demonstrations and qualification of new and improved components and refrigerants, validation of new operating procedures, and troubleshooting existing fleet issues. It supports environmental issues brought forth through the Navy CFC Elimination Program, as well as provides fleet technical training support through the use of the *Virginia* Class AC Plant Crew Training Facility. In the future, this site will be required in the area of thermal management where alternative air conditioning systems and new technologies will be tested and evaluated to help prepare the Navy to fight in the ocean's littoral regions, where the warmer weather and higher seawater temperatures will have a substantial impact on the thermal load of ship designs.

Site Manager,
Ken DiFonzo.....215-897-1524 (DSN 443)

Machinery Data Repository

This 400-square-foot facility is the single, authoritative source for U.S. naval machinery engineering data. In addition to housing the data, tools are provided for content management. All the Navy's planned maintenance system and operating sequencing system data are managed in the repository. The Philadelphia-based repository also hosts all digital machinery technical manuals. This single repository provides the Navy with economies of scale and the ability to share data elements among these product lines. The Machinery Data Repository is the Navy's largest standard generalized markup language (SGML) database. Additionally, industry uses the repository to manage and store engineering technical data.

Site Manager,
Tom Bodman..... 215-897-7804 (DSN 443)

Underway Replenishment (UNREP) Test Site

Located in Port Hueneme, this site is the only fully equipped and operational UNREP test site. It contains modern constant tensioned fueling and cargo systems with Navy standard equipment that represents the latest configurations for both the delivery and receiving parts of the system. The UNREP Test Site is used to fully test new systems, equipment, and configurations under the controlled conditions, safety, and economy of a dedicated land-based facility. It is also used extensively to train both Navy and civilian crews, as well as to demonstrate UNREP procedures, systems, equipment, and new developments to sponsors, fleet representatives and others. As a fleet technical assistance site, it is used to simulate or duplicate UNREP problems reported by the fleet and to develop special repair procedures. Lastly, the site is used to overhaul and test items turned in by the fleet and return them in operational condition.

Site Manager,
Bob Hilger..... 805-228-7994 (DSN 296)

The Machinery Systems Core Equity takes advantage of the Permanent Test Site Planning Committee to effectively manage its test sites in Philadelphia. The committee ensures that the test sites remain the foundation of machinery research and engineering efforts for the near and distant future. The committee also ensures that the test sites are environmentally sound, are safe for operation, and remain current and effective.

The S^3 PA's Machinery Systems Core Equity supports a wide variety of hull, mechanical, and electrical systems. With this diverse arena, only a small sampling of test sites could be featured here.

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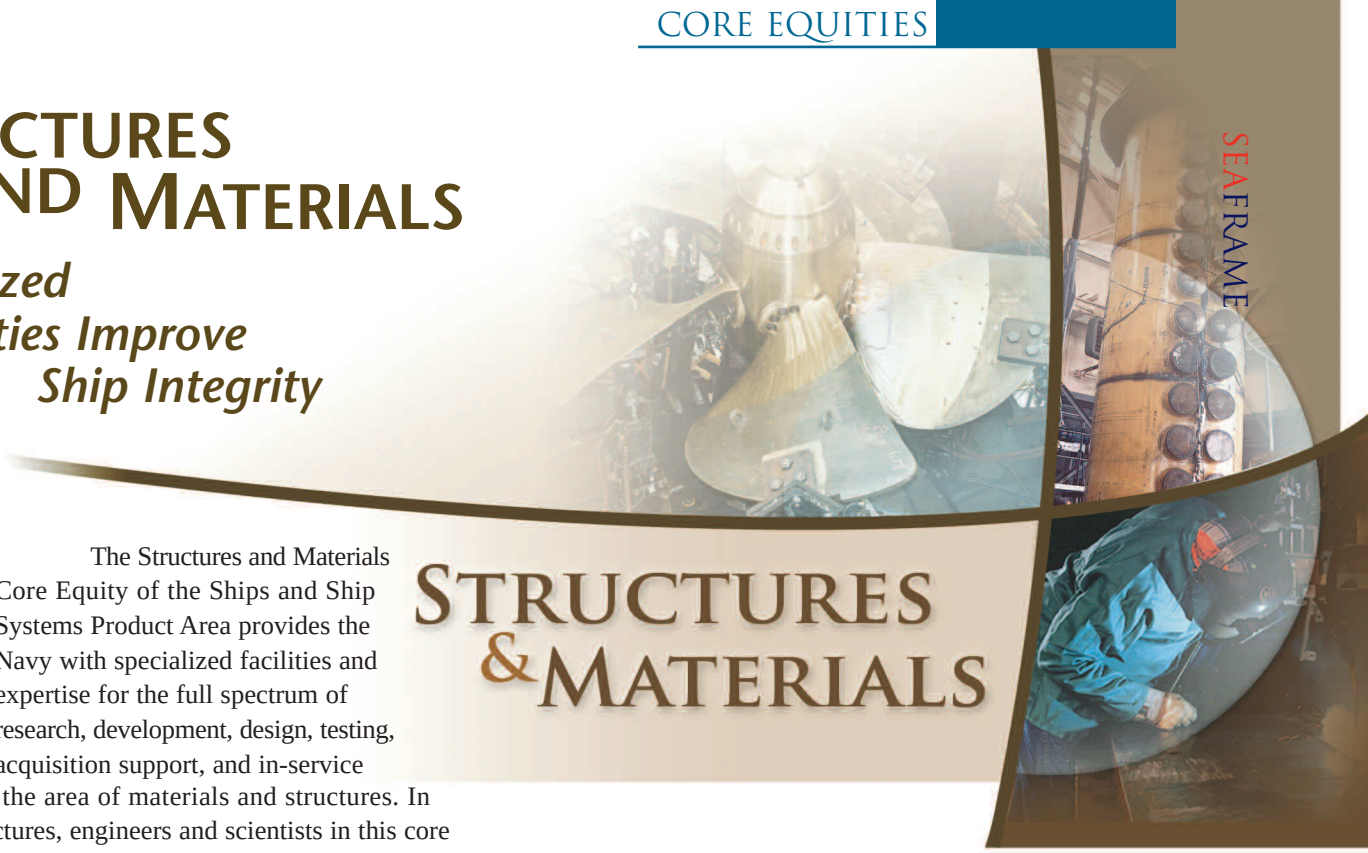
STRUCTURES AND MATERIALS

Specialized Facilities Improve Ship Integrity



By Leslie Spaulding

The Structures and Materials Core Equity of the Ships and Ship Systems Product Area provides the Navy with specialized facilities and expertise for the full spectrum of research, development, design, testing, acquisition support, and in-service engineering in the area of materials and structures. In support of structures, engineers and scientists in this core equity focus on concepts, large- to full-scale testing, and design analysis methods to ensure stronger, lighter, and more reliable ships and submarines. The materials work involves development, transitioning of novel products and processes, and fleet support in metals, corrosion, welding, non-destructive testing, coatings, elastomers, polymers, ceramics, composites, batteries, fluids, and fire protection.

In support of all of this work, the Structures and Materials Core Equity established and maintains a variety of unique facilities at both the Carderock and Crane Divisions. These world-class laboratories and test sites aid the Navy, and in some cases, academia, other government agencies, and private industry, in the overall design and integrity of structures and materials. The following are just some of the many facilities supporting work in this area:

The 3000C 50-ton hot press is one of the most important pieces of equipment in the Advanced Ceramics Facility. It is used to densify ceramic materials.
Photo by Dr. James Zaykoski, NSWC Carderock Division.

Advanced Ceramics Facility

With its extensive and comprehensive suite of equipment, this facility is used to develop and test ceramics, composites, high-temperature materials, refractory metals, and materials for extreme environments. Much of the equipment found in this West Bethesda site is unique within the Department of Defense (DoD) and rare to this country. The equipment has capabilities (pressure, temperature, etc.) that exceed common values. The suite includes a hot press (3000 C), tungsten element furnace (3000 C), hot isostatic press (2200 C/45000 psi), x-ray diffractometers, mechanical test equipment (1500 C), and much more. Recently, a zirconia element furnace (2000 C in air) was added. In FY 07, under the Capital Purchase Program, new x-ray diffraction equipment will be added to update/improve the existing facilities. Overall, the current replacement cost of this facility is more than $4M. The unique equipment and the depth of expertise found in the Advanced Ceramics Facility attract work from academia and private industry, as well as other government agencies, for help in processing and analyzing ceramics and high temperature materials.

Site Manager,
Curtis Martin..... 301-227-4501 (DSN 287)

STRUCTURES AND MATERIALS (Continued on page 22)

STRUCTURES AND MATERIALS (Continued from page 21)

Deep Submergence Pressure Test Facility

The pressure tanks of this hydrostatic pressure test facility provide the Navy and the maritime industry with the capability to test marine structures, components, and systems in an environment that simulates deep ocean depths. Located at West Bethesda, the tanks range in size from 15-inch diameter by 3.5-foot depth to 13-foot diameter by 40-foot depth with pressures up to 25,000 psi (approximately 11,000 feet). This facility recently certified the pressure hulls for the *Virginia* Class submarine and the Submarine Rescue Diving and Recompression System. Future testing will include certification of the Alvin 2 bathysphere and proof testing of repair equipment for undersea pipeline.

Site Manager,
David Leasure..... 301-227-0294 (DSN 287)

The Deep Submergence Pressure Test Facility can simulate the depth of up to 11,000 feet of seawater.
Photo by Dave Leasure, NSWC Carderock Division.

Electrochemistry Facilities

These facilities, located at West Bethesda, MD, comprise the Navy's most extensive research, development and technology transition, characterization and evaluation resource addressing electrochemical power and energy generating materials, interfaces, structures and devices. These facilities support the Navy's current, developing, and future needs. These devices include batteries, super-capacitors, fuel cell systems, and other alternative power and innovative energy devices, and range in size from microwatt to megawatt-hour systems. The facility's capabilities cover the spectrum from basic material synthesis and characterization to prototype battery assembly, as well as supporting the behavior and performance characterizations. Capabilities include determination of fundamental material properties through to determining cycle-life efficiency, cost-effectiveness, and safety of deployed and embedded power systems. Specialized facilities include dedicated high-energy event characterization chambers, inert-gas and dry-room facilities, and several hundred channels of cycling systems for continuous, automatic evaluation of new materials and electrochemical designs. The engineers and scientists supporting these facilities cultivate teams and partners and work closely within academia, industry, Navy, and with numerous government customers to accelerate the transition of new power and energy technologies to meet current and future needs.

Site Manager,
Peter Keller ..... 301-227-1833 (DSN 287)

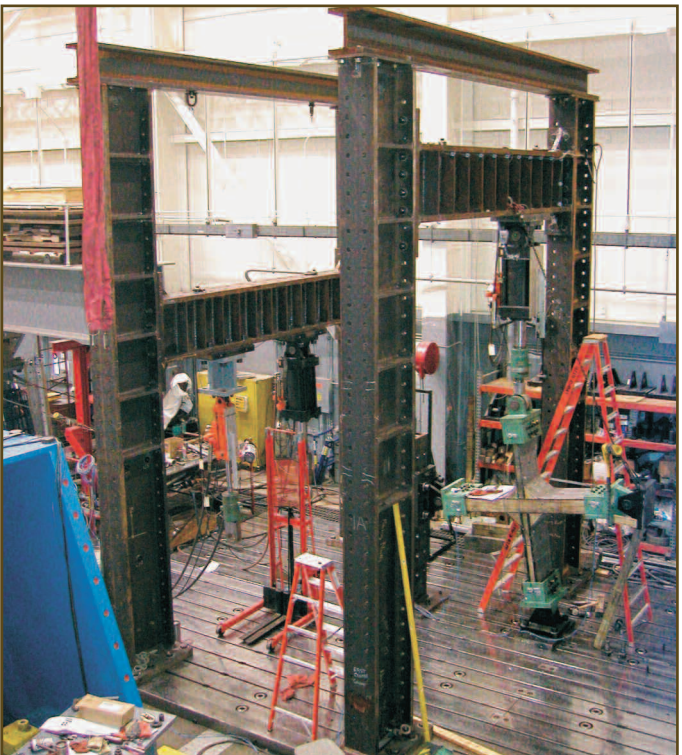
Michelle Cervenak processes specialized electrodes using the electrode coater in the Electrochemistry Facilities.
Photo by Ryan Hanyok, NSWC Carderock Division.

Electrochemical Power Systems Facility

This facility, located at Crane, IN, provides a full spectrum of support for electrochemical power systems, including batteries, fuel cells, and ancillary equipment. It is the DoD's largest dedicated battery facility, with more than 120 unique specialized battery test systems replicating battery activation, load profiles, and charge and discharge regimes supporting 2.1 million test hours annually. Operation is maintained 24/7, 365 days per year in support ranging from applied research through system retirement. Within this facility, the High-Energy Battery Evaluation and Abuse Complex is unique world-wide and was designed to test and evaluate the latest technology batteries in a safe and ecologically suitable manner. Identified by the Office of Naval Research as a key national asset, it provides 10 explosive-proof total-containment test cells for safety evaluation. Construction on the Electrochemistry Engineering Facility was completed in 2005 and adds five medium hazard environmental test cells designed for fire mitigation, integrated test and environmental condition, a prototype lab, and a failure analysis lab with built-in dry room. Cooperative teaming agreements are in place between this facility and R&D activities, industry, universities, and other government agencies to provide a network of knowledge and enhanced capabilities.

Site Manager,
Randy Haag..... 812-854-6984 (DSN 482)

The multifunctional Free Form Test Frame is used for large-scale structural testing.
Photo by Michael McDonald, NSWC Carderock Division.



Fatigue and Fracture Laboratory

In dealing with materials, it's crucial to understand fatigue and fracture. This lab, located in West Bethesda, is used to characterize basic material properties and conduct specialized fatigue and fracture mechanics tests. The lab is also used for small-scale structural validation testing, failure analysis, and high-rate material evaluation. Its high-rate test machines, drop towers, and specialty fatigue and fracture testing make this a unique laboratory, which is used not only by Navy but by the Nuclear Regulatory Commission, the United States Naval Academy, Ingalls Shipbuilding, Northrop Grumman Naval Shipyard, and the University of Illinois. Ongoing upgrades on the test frame control systems and all computer hardware/software is advancing the lab's capabilities. Additionally, a new Charpy test machine for impact testing is being designed and installed in conjunction with Johns Hopkins University. Further expansion includes the transfer of a dynamic tear machine from Lawrence Livermore National Laboratory and the addition of equipment from Fort Lauderdale.

Site Manager,
Jeff Mercier..... 301-227-5464 (DSN 287)

Free Form Test Frame

Located at West Bethesda, in the Structural Evaluation Laboratory, the Free Form Test Frame (FFTF) is a multi-functional test frame designed to be reconfigurable to meet most large-scale structural testing requirements. The FFTF consists of three 20-foot-tall, 15-foot-wide steel arches, which are each capable of supporting a 600 kip tensile or compressive vertical load from each of the horizontal header beams. The heights of the header beams are adjustable in six-inch increments up to the full height of the fixture. For complex load cases, load may also be applied horizontally off the inner faces of the vertical columns. A T-slotted test floor below all three arches increases the test frame's versatility by allowing maximum flexibility when designing base fixturing and locating test articles.

Site Manager,
Donald Becker..... 301-227-3953 (DSN 287)

STRUCTURES AND MATERIALS (Continued on page 24)

STRUCTURES AND MATERIALS (Continued from page 23)

Friction Stir Welding and Processing Laboratory

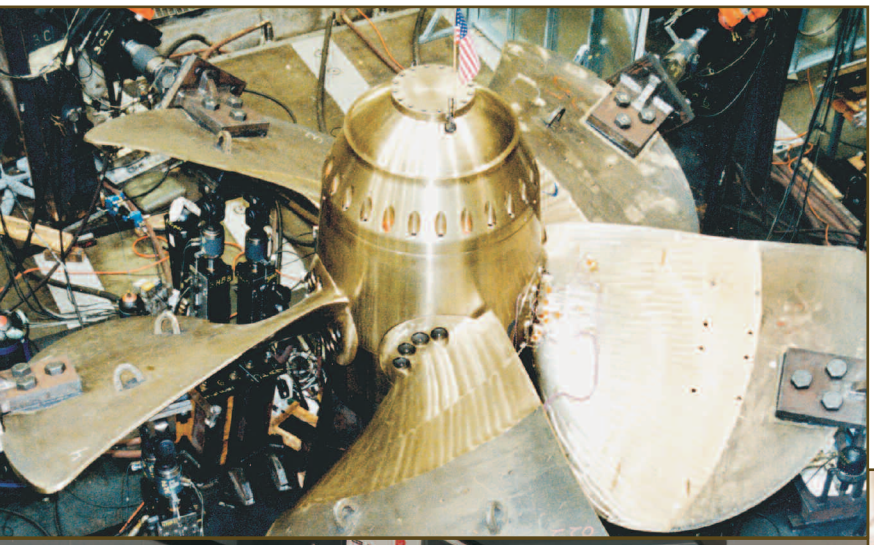
This West Bethesda-based laboratory is used to develop and validate friction stir welding and processing procedures for joining and surface modification of naval alloys. This is the only facility within the Department of Defense with this capability. Friction stir welding and processing is the most recently-developed welding process with a potential for wide-ranging industrial applications. Personnel supporting the S^3 Structures and Materials Core Equity are collaborating with Northrop Grumman Ship Systems on friction stir welding of 5000 series aluminum alloys, with the Naval Postgraduate School and Rockwell Scientific on friction stir processing of nickel aluminum bronze, and with Ohio State University on friction stir welding of steels. The laboratory, itself, was purchased through the Capital Purchase Program.

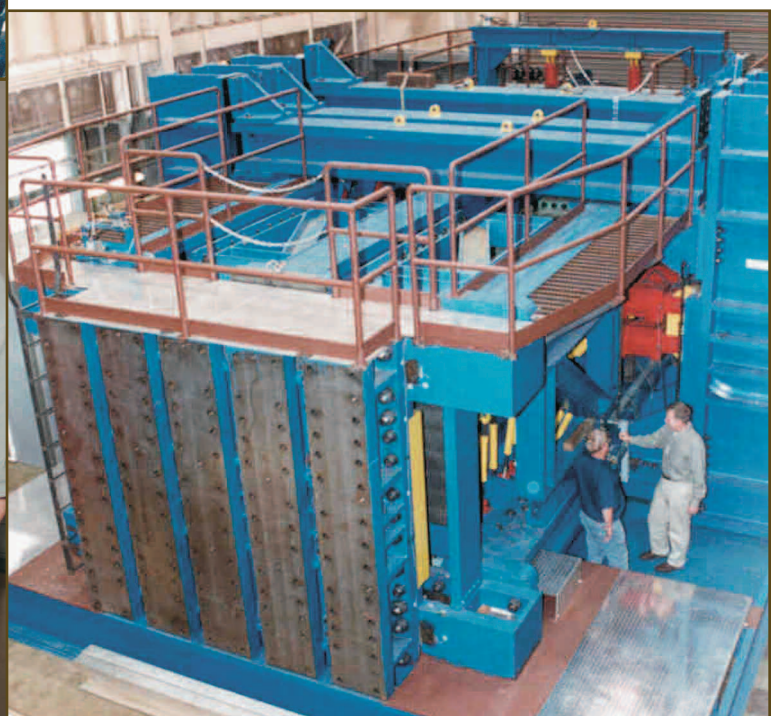
Site Manager,
Maria Posada..... 301-227-5017 (DSN 287)

Grillage Test Facility

Located in West Bethesda, the Grillage Test Facility provides a means to experimentally evaluate the ultimate strength and modes of failure, as well as post-failure residual strength of full-scale cross-stiffened ship hull plating. The results are usually compared with analytical or numerical predictions. Grillage test specimens as large as 8 feet in width and 24 feet in length can be subjected to axial in-plane loads of up to +/- 5 million pounds in the longitudinal direction, +/- 1 million pounds in the transverse direction, and hydrostatic uniform pressure loadings of up to 25 psi–acting individually or simultaneously. Although typically used to evaluate steel configurations, the test facility was recently used to evaluate the structural performance of fiber-reinforced composite grillages to support the Composite High Speed Vessel Program.

Site Manager,
Dr. David Kihl..... 301-227-1956 (DSN 287)





Left: The Structural Evaluation Lab was recently used to test the prototype LPD 17 Class controllable-pitch propeller.
Photo by Pam Lama, NSWC Carderock Division.

Left Corner: Rick Benzel processes experimental welding rods using an extrusion press at the Welding Consumables Development Laboratory.
Photo by Ryan Hanyok, NSWC Carderock Division.

Below: The Grillage Test Facility is used to evaluate the initial ultimate strength and modes of failure as well as post-failure residual strength of full-scale cross-stiffened ship hull plating.
Photo by Dr. David Kihl, NSWC Carderock Division.

Materials Engineering and Fluid Processing Laboratory

The cross-functional equipment found in this Philadelphia-based laboratory allows for metallurgical analysis of failed metallic components, as well as failed software and fluids of the system being investigated. The lab is primarily used to investigate system failures in the fleet; however, it is also used for analyzing system petrofluids and water. When investigating failures and developing appropriate corrective actions, the synergies between metallic, nonmetallic, and system fluids are often overlooked. The unique capabilities found in this lab allow for failure investigation in the full ship's system and root causes of failure that exist as a result of the relationships between system components. The Materials Engineering and Fluid Processing Laboratory was recently modified through the Capital Purchase Program to include a Fourier Transform Infrared microscope, petrofluid wear metals analyzer, petrofluids rotating bomb oxidation test, and fastener vibration tables–all of which expanded the investigative capabilities of the site.

Site Manager,
James Soisson..... 215-897-1628 (DSN 443)

Structural Evaluation Laboratory

This large experimental test facility at West Bethesda is used to evaluate the structural performance of unique, complex ship structures under static, dynamic, or cyclic loads. The facility has a 39-foot by 97-foot reinforced test floor with load tie-downs on 5-foot centers. Loads are applied to large- to full-scale ship sections using a closed-loop servo-controlled hydraulic system capable of controlling multiple actuators. The Structural Evaluation Laboratory was used to simulate seaway loads on a 1/3-scale aluminum destroyer model and more recently to test the prototype LPD 17 Class controllable-pitch propeller–submitting the propeller's assembly to full lifetime worst case loads totaling 17 million loading cycles.

Site Manager,
Donald Becker..... 301-227-3953 (DSN 287)

Welding Consumables Development Laboratory

Located in West Bethesda, this laboratory is used to develop, fabricate, and evaluate experimental welding consumables, such as covered electrodes, solid wires, and flux-cored wires. It is the only Department of Defense facility capable of fabricating custom experimental welding wires. Because the Navy is a relatively small market, commercial manufacturers are hesitant to invest research and development in Navy-unique products. Therefore, the Welding Consumables Development Laboratory allows the Navy to develop custom wires to meet its unique naval challenges in a timely manner.

Site Manager,
Gene Franke..... 301-227-5571 (DSN 287)

The S^3 Structures and Materials Core Equity is the only substantive organization in the United States that performs research, development, test and evaluation on marine structures and offers full-spectrum technical support for ship and submarine structures and materials. The scientists and engineers supporting this core equity possess the unique understanding of the synergy between this core equity and machinery systems and components in providing engineering solutions for the acquisition and maintenance needs of naval assets. Additionally, its ship and submarine materials work has affected all aspects of the fleet for more than 90 years and continues into the 21st century. Absolutely key to this capability, service, and knowledge are the myriad testing facilities and labs–some of which are featured here. For a more complete listing, go to www.dt.navy.mil/sur-str-mat.

Core Equity Leader, Structures and Materials
Stephen Roush
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301-227-3412 (DSN 287)

Two Science and Engineering Apprentice Program students dissect a battery in preparation for testing of its capabilities and limits.
Photo by Ryan Hanyok, NSWC Carderock Division.

Environmental Quality Systems

Environmental Quality Systems Facilities

"Green" Solutions for the Navy's Waste Management Afloat and Ashore

By William Palmer

The Navy's Environmental Quality vision for warships of the 21st century is to provide them with the necessary equipment and systems to permit operations anywhere in the world without environmental regulatory constraint and without being subjected to pay unreasonable costs imposed by environmental regulations. Without the environmental quality engineering technical capability, located at the Naval Surface Warfare Center, Carderock Division (NSWCCD), the Navy's ability to meet the operational and readiness objectives of the Navy's Joint Mission Areas would be compromised.

This core technical capability, which supports the work of the Ships and Ship Systems Product Area, exists at West Bethesda and Philadelphia facilities. In addition, it supports unbiased qualification testing and evaluation of innovative naval environmental systems and commercial technologies for the U.S. Navy, Army, and Coast Guard, the Military Sealift Command, as well as commercial vessels.

Six unique laboratories support research, development, test, evaluation, in-service engineering (ISE), and fleet support of materials, processes, and systems leading to full compliance with regional, national, and international environmental regulatory requirements:

Thermal Destruction Facility and the Solid Waste Laboratory

These are two state-of-the-art facilities used to investigate processes, operations, and systems designed to manage shipboard generated solid waste. These fully instrumented laboratories provide the Navy with a means of performing independent and objective testing and validation of commercial-off-the-shelf (COTS) and developmental pollution control technologies prior to costly shipboard trials and later fleet deployment. The Thermal Destruction Facility is the only Navy RDT&E facility that is permitted and has equipment such as an exhaust stack, off-gas treatment, and continuous emissions monitoring to perform testing on incinerators.

Facility Manager,
Stephen L. Baylin..... 301-227-5171 (DSN 287)

A bag of material is placed into the plastic disc processor of the compression melt unit.
Photo by Jessica Klotz, NSWC Carderock Division.

Wastewater Management Laboratory

This lab facilitates operation and evaluation of both commercially available and emerging shipboard wastewater treatment technologies against Navy requirements. This research and development (R&D) laboratory offers the capability of performing testing for full-scale bilgewater treatment technologies (up to 50 gallons per minute) and supports test and evaluation of commercial marine sanitation devices. In addition, NSWCCD has a full-service, on-site biotechnology laboratory that offers microscopy and the facilities and equipment to determine a variety of wastewater analytical metrics. This laboratory deals with major shipboard liquid waste streams. Scientists at this facility work with treatment of oily waste contaminated bilgewater and develop and evaluate technologies for treating graywater, or wastewater from such sources as showers, sinks, laundry, galley, and scullery, as well as blackwater, or sewage from toilets and urinals. The group's expertise and core knowledge base, combined with the laboratory capabilities, are in wastewater treatment system design, development, operation, assessment, testing and evaluation to expertly integrate the latest commercially and university-developed technology into products for today's commercial maritime and military vessels.

Site Manager,
Charles M. Kelly..... 301-227-5154 (DSN 287)

Ship-to-Shore Environmental Quality Laboratory

This lab facilitates proof-of-concept and scaled testing of wastewater treatment and industrial process technologies designed to reduce the impact of Navy operations on the environment and to provide operational and maintenance benefits to the fleet. The laboratory is being equipped to support research in the areas of advanced in-water hull cleaning, underwater surface preparation/ painting, and mobile surface cleaning, and also to facilitate testing of advanced technologies including chemical precipitation, membrane filtration, media filtration, mechanical separation, and electrocoagulation. The lab will be utilized primarily for the testing and evaluation related to the treatment of various forms of wastewater.

Site Manager,
Stephen L. Baylin..... 301-227-5171 (DSN 287)

ENVIRONMENTAL FACILITIES (Continued on page 28)

The Ship-to-Shore Environmental Quality Lab tests wastewater treatment and industrial process technologies, which reduces impact of Navy operations on environment and provides benefits to the fleet.
Photo by Martin Sheehan, NSWC Carderock Division.

Laboratory personnel monitor equipment in the Wastewater Management facility.
Photo by Martin Sheehan, NSWC Carderock Division.

ENVIRONMENTAL SYSTEMS (Continued from page 27)

Radiation Technology Group

For more than 40 years, this group has provided science and technology support to the Naval Sea Systems Command, SEA 04LR. It has been involved in virtually every aspect of the RADIAC (Radiation Detection, Indication, and Computation) Program Office's personnel dosimetry and radiation protection efforts. The primary facility is a radiation range capable of delivering carefully controlled exposures of ionizing radiation. Two gamma irradiators are used to support the gamma radiation dosimetry system used by Naval Reactors (SEA 08R). The calibration of these two devices is traceable to the National Institute of Standards and Technology (NIST). This capability allows the gamma detection system to maintain National Voluntary Laboratory Accreditation (NVLAP). The facility also contains an AN/UDM-10 neutron source and an x-ray generator which provides the capability to test and evaluate the response of dosimeters and detectors to a wide range of energies and radiation types. The Navy considers personnel dosimetry so paramount that all readings become part of an individual's medical record. The standardization, calibration, and quality assurance programs conducted at Carderock ensure that those values are correct and meaningful. The Navy's Radiological Affairs Support Office and Carderock Division's Radiation Safety Office routinely conduct radiation safety audits of this facility to ensure it meets current Navy and Federal radiation safety requirements.

Site Manager,
Mary Jo Bieberich..... 301-227-4978 (DSN 287)

NSWCCD equipment specialist (Tom Nesbitt) conducts testing of a new commercial-off-the-shelf (COTS) shipboard sewage pump cartridge seal being installed fleetwide as a Machinery Alteration (MACHALT).
Photo by Martin Sheehan, NSWC Carderock Division.

A radiation lab engineer records meter readings. The Navy takes the personnel dosimetry very seriously, and all radiation readings become part of an individual's medical record.
Photo by Martin Sheehan, NSWC Carderock Division.

NSWCCD engineers (Tim Kurylo and Mary Lee) prepares Automated Oil Pollution Abatement (AOPA) System for full-scale laboratory testing.
Photo by Martin Sheehan, NSWC Carderock Division.

ISE Pollution Abatement Engineering Laboratory

Located in Philadelphia, this site is uniquely outfitted to simulate current fleet shipboard pollution abatement systems. This laboratory provides the capability to test fleet configurations to ensure effective shipboard pollution abatement systems are deployed and maintained. The laboratory also ensures fleet operators and Type Commanders have the opportunity to thoroughly evaluate COTS technologies and maintenance processes designed to reduce waste or more effectively process it. The facility contains fully operational oil/water separators, including a newly developed high-flow separator system recently approved for fleetwide installation. Also found at the site are a fully automated oily waste transfer system, injection systems, oily waste conditioners, variable speed separator pumps, oil content monitors and all associated support system tanks, piping, and valves to perform controlled testing under a wide range of potential influent characteristics. The lab includes a collection holding and transfer (CHT) system pump group and a complete vacuum sewage collection, holding, and transfer (VCHT) system including pumps, ejectors, vacuum piping and fixtures to test alternate sewage system components. A solid waste laboratory is also on site, which features legacy plastic waste processors (PWP) including the recently developed improved MOD I PWP system that is currently being deployed fleetwide, pulpers, solid waste shredders, garbage grinders, and document destructors. Finally, the lab offers an analytical chemistry lab with necessary analytical hardware and tools for waste and wastewater characterization and system effluent monitoring, as well as air emissions monitoring equipment to support equipment evaluations.

Site Managers,
Steve Novielli..... 215-897-7181 (DSN 443)
Richard Ruediger..... 215-897-7267 (DSN 443)

The NSWCCD Environmental Quality (EQ) Division is recognized by the Naval Sea Systems Command as its research and engineering design capability for shipboard and ship-to-shore environmental quality systems and as its resident corporate expertise for technology applications. EQ engineers and scientists are applying their specific knowledge, environmental expertise, and understanding of unique Navy shipboard system requirements and constraints to be sure the Navy "buys smart" and innovatively applies new technologies for 21st century ships.

Core Equity Leader, Environmental Quality Systems
Peter McGraw
peter.mcgraw@navy.mil
301-227-1668 (DSN 287)

VULNERABILITY & SURVIVABILITY SYSTEMS

SHOCK TEST POND

Providing a Unique Testing Environment

By William Palmer and Donald Melick

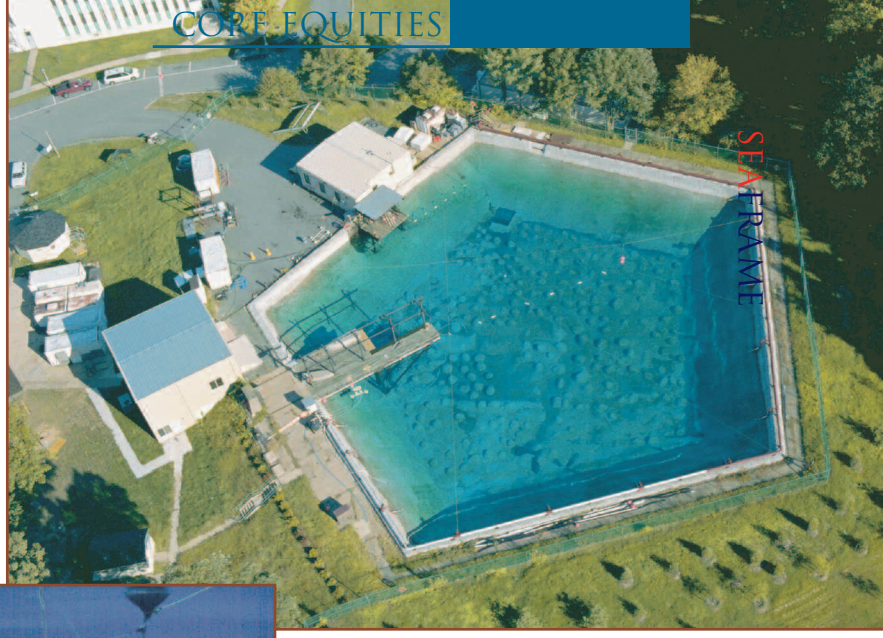
The Naval Surface Warfare Center, Carderock Division, utilizes a wide variety of unique testing facilities, some of these considered national assets in the shipbuilding arena. These unique facilities include the Damage Control Sensor System Engineering Site at Philadelphia, which advances the survivability of Navy ships and their crews. Another facility, the Dynamic Measurement Annex at West Bethesda, supports model testing with calibrated instruments and fabrication capabilities. Other assets include the Shock Test Pond at West Bethesda (discussed below); the Protection Analysis Center in West Bethesda, which serves as a state-of-the-art classified computing and conference facility; and the Perryville Test Preparation Facility near the Aberdeen Proving Grounds in Maryland, which is a staging station to prepare model testing for scheduled test series. These are all maintained and operated in part to ensure changing Navy mission needs are met with accommodation and flexibility.

The Shock Test Pond is one of the critical facilities used by the Ships and Ship Systems (S^3) Product Area (PA). Constructed in 1943, the "pond," as it is referred to around West Bethesda, was originally built to support the development of caissons to be used during the D-Day allied invasion of beaches in Normandy, France. The location was chosen since it was remote at the time.

Initially, as much as 10 pounds of high explosives could be used in tests. Currently, due to the proximity of "recently" constructed buildings, the presence of the Clara Barton Parkway, and more exacting Navy regulations controlling use of explosives, a maximum of 3 pounds of explosive materials is permitted for use in testing at the pond. Typically, most tests today are conducted using a pound or less. Since the facility's inception, it has an unblemished safety record.

A variety of testing programs are regularly performed at the pond. The primary work focuses on testing and evaluating new structures, materials and protection concepts against weapons effects. Small-scale test articles are fabricated, and tests are conducted to improve the Navy's understanding of underwater explosions and to identify methods to mitigate those effects. Once these smaller-scale tests are completed, modifications and improvements can be incorporated into the design, and larger-scale models can be constructed for additional testing at the pond or another test facility. The pond has also been used for performing trajectory tests of objects dropped from above the surface of the water, testing of underwater explosives for other Warfare Center product areas, and improving the Navy's understanding of underwater explosion phenomenology.

The design of the pond and the ability to obtain high quality, underwater explosion video imagery is what makes this facility unique. The pond's water is filtered and chemically treated to maximize underwater visibility. This visibility is crucial to sponsors who fund this work because test plans almost always include underwater photography and videography. Water from commercial sources,



Right: The Navy's shock test pond, where a variety of testing programs are regularly performed. Primary work involves testing and evaluating new structures, materials, and protection concepts against weapons effects, improving understanding of underwater explosions and mitigation of their effects.
Photo provided by the NSWC Carderock Division Photographers.

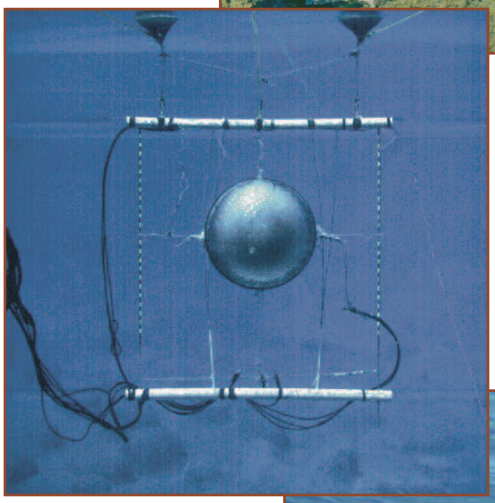
although used in the pond, is unacceptable since it is required to be heavily filtered and chemically treated. A custom-designed surface skimmer, with an internal sand filter, eliminates surface contaminants. For example, when it rains, that surface contamination is driven into suspension within the pond's water. Then the pond's two-stage cartridge filtration system, consisting of a pre-filter element and a final-stage element, eliminates virtually all particulates in the water above 5 microns in size (one micron equals one thousandth of an inch). When required by test agendas, the water can be filtered to 3 microns.

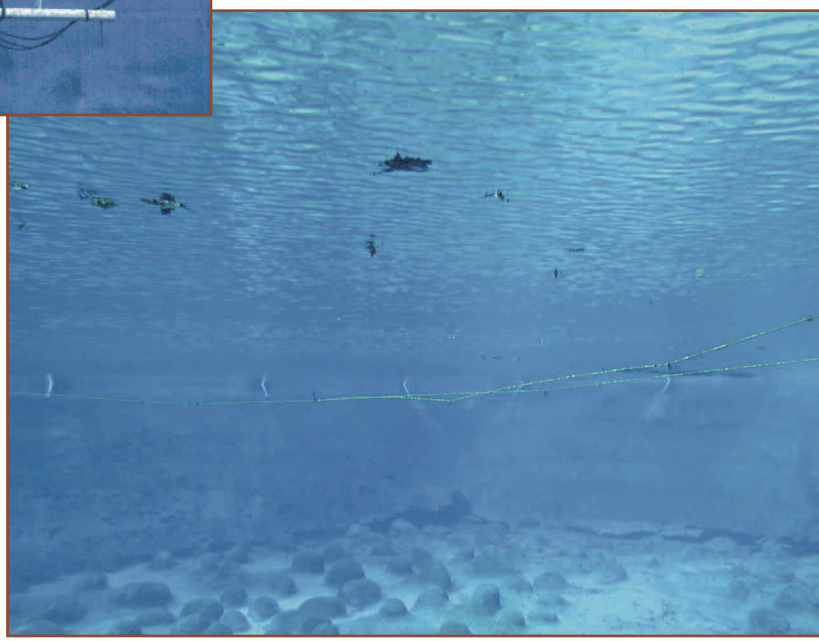
The filtration system contains 88 cartridges and has to be changed any time from weekly to monthly. As seen in the pictures, the blue tint in the water is caused by a copper-based commercial algaecide.

When filtered and treated, one can see clearly through the pond's 25-foot depth to the bottom, and this near-perfect clarity is what sponsors desire and what photographers and videographers need for their end-products. The resulting visual documentary of the condition of a scale model or weapon following exposure to an explosion is extremely valuable to sponsors.

The pond volume is 3.5 million gallons of water, and since it's outside, about one inch of water evaporates from the pond daily, making it necessary to top off the pond about once a week.

Several other facilities can conduct UNDEX tests, but none have the water clarity and video capability combined with the instrumentation or data recording which can be accomplished at the shock test pond. It is through the continuing maintenance and use of this facility that the Vulnerability and Survivability Systems Core Equity is sustaining a high level of excellence in bringing high-quality testing capabilities to customers, leading to improved survivability of the fleet.





Left and Below: High-speed photography records the initiation of an underwater explosion in the test pond. Clarity of water is such that piping mounted on the far wall of the pond, 180 feet away, can be seen.
Photos provided by the NSWC Carderock Division Photographers.

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SIGNATURES, SILENCING SYSTEMS, & SUSCEPTIBILITY

SIGNATURES FACILITIES

Operating Technical Facilities in a Business-Oriented Environment

By Garth Jensen and Gerald Smith

The Navy is caught between the two competing forces of mission execution and sound fiscal management. As a research, development, test, and evaluation (RDT&E) activity, Naval Surface Warfare Center, Carderock Division faces a compelling need for research laboratories and test facilities, which are essential to the validation of theory, computer modeling, engineering modeling, and design implementation. As a Navy Working Capital Fund (NWCF) organization, Carderock Division is required to develop, maintain, and in some instances, mothball or close those facilities that are not customer required or fiscally viable to meet its fiscal obligations. As engineers and scientists, there is always the desire to keep every facility and laboratory operating, regardless of the financial cost. As prudent business managers, the decision to no longer invest in, and in fact, close facilities is a must if no compelling business reason exists. Over the years, the leadership of the Signatures, Silencing Systems, and Susceptibility Core Equity built or acquired numerous test facilities to satisfy clear emerging program needs. There was always the understanding that at some future time the facility may have to be mothballed or closed.

There is a minimum base set of facilities that should always be available to test proof of concept, but beyond that, the core equity conducts a periodic business case analysis to determine if a given facility should be maintained, enhanced to meet future customer needs, or closed because no long-term requirements can be identified. This business case is always conducted in concert with previous or current customers. By involving customers, the core equity can obtain a level of financial commitment from those who believe a facility should be kept available. Many support major ship programs and are included in program budgets. The other facilities are used across a broad customer base, and clear sustainable funding may not be as identifiable. It is in the latter instances where the business case analysis is most focused. Such an approach has been very successful in allowing the leadership to make informed decisions.

Several case histories are presented, with differing scenarios regarding program direction or customer requirements, which portray the necessary management level decisions faced when the competing forces come into play.

USNS Hayes

The *USNS Hayes* replaced the Mobile Noise Barge (MONOB) in the mid-1980s and entered service in 1993. At the time there were a number of unique programs that required frequent change out of measurement array systems, a requirement that made installing a fixed array system impractical. Over time the unique programs ended, and the remaining customer, NAVSEA 392, continued to fund the operational costs of the ship. Facing an expensive overhaul and rising operation costs, the customer asked the Division to develop alternative scenarios to conduct submarine acoustic testing on the east coast.

Earlier the Naval Underwater Warfare Center Newport (NUWCNPT) and Carderock Division had collaborated on a proposal to place a fixed array system in South Tongue of the Ocean (STOTO), Atlantic Undersea Test and Evaluation Center (AUTEC), that could leverage off existing infrastructure. However, the up front costs of designing and installing the required

USNS Hayes, a long-time acoustic testing platform for at-sea submarine acoustic analysis. *Hayes* is being replaced by a fixed measurement system mounted on the ocean floor.
Photo provided by Gerald Smith.

LSV 2, the current autonomous submersible testing vehicle used by Navy researchers at the Acoustic Research Detachment in Bayview, Idaho.
Photo provided by Gerald Smith.

system was prohibitive. Core equity leadership again approached the customer with a plan to leverage off a new SEAFAC array design and procurement, forego long-term upgrades to the *Hayes* array systems, and delay submarine acoustic tests for one year to fund the procurement and installation of a system at AUTEC. With NAVSEA concurrence, Carderock Division working with NUWCNPT personnel, initiated the program which is well underway. The array system will meet all current and future requirements without the need for new development funds. The system will be installed at AUTEC to leverage off the existing infrastructure and will ultimately save up to $4 million per year over the current operation with *Hayes*. This program is an excellent example of cooperation between two Warfare Centers.

Acoustic Research Detachment Large Scale Vehicle

The Large Scale Vehicle 1 (LSV 1) (*Kokanee*) was built as a test platform for the development of the propulsor for the *Seawolf* Class and future classes of submarines. A free-running, computer-controlled, one-fourth-scale model, LSV 1 was delivered in 1987. The propulsor test program began, and 19 different variants and a final design unit were tested.

As the *Seawolf* design was completed, *Kokanee* was used to conduct studies of the maneuverability of submarines. When the Navy determined that the next generation submarine would be different in form, *Kokanee* did not provide the required propulsor inflow profile. However, the large model concept had proven so successful that the Navy decided to invest in a new model that more closely represented the hull form for the new *Virginia* Class. Once LSV 2 (*Cutthroat*) was delivered, *Kokanee* was used to study other *Seawolf* noise-related phenomena.

The long-term outlook for work on *Kokanee* was poor, and the only logical approach was to lay the ship up. Core equity leadership, working with the LSV 1 customer, reached an agreement to mothball *Kokanee*. Discussions are still ongoing as to the future disposition of the vessel.

Santa Cruz Radar Imaging Facility

In the mid-1980s, Santa Cruz Radar Imaging Facility (SCRIF) was established to support a unique program that had special requirements for radar measurements at various elevation angles. High quality radar measurement systems were designed and installed on the island. The program provided generous funding to support the facility and its infrastructure. As the peak portion of the testing phase of the program concluded, limited Major Range and Test Facility Base (MRTFB) funding was established to continue the infra-structure support for the intermittent periods when the systems would be needed. Carderock Division was encouraged to seek other customers that could take advantage of SCRIF so that the costs could be accrued across multiple parties. Carderock Division sought to provide services to fleet assets that required periodic RCS measurements to ensure that stealth systems were operating as designed.

The fleet was enthusiastic about the facility but due to budget pressures to reduce fuel expenditures focused more of its efforts in the San Diego/San Clemente operating areas. Further budget cuts decreased the amount of MRTFB funding. The core equity, recognizing the decrease in fleet activity and the impact of no MRTFB funding, advised all customers that without strong endorsement and a commitment of funding, SCRIF would be closed. The facility was shut down.

SIGNATURE FACILITIES (Continued on page 34)

The Santa Cruz Radar Imaging Facility performed high quality radar measurements.
Photo provided by Gerald Smith.

The Fox Island Laboratory complex, a portion of which was the range house for the Carr Inlet Acoustic Range.
Photo provided by Gerald Smith.

SIGNATURE FACILITIES (Continued from page 33)

Carr Inlet Acoustic Range and the Santa Cruz Acoustic Range Facility

The Carr Inlet Acoustic Range (CIAR) located in southern Puget Sound, WA, was one of the earliest acoustic test ranges developed by the Navy. Developed circa 1957, the range served both submarines and surface ships operating on the West Coast. In the early 1970s, high-speed operations at CIAR were determined unsafe, so Santa Cruz Acoustic Range Facility (SCARF) was installed off Santa Cruz Island, CA, for high-speed tests. Over time both facilities became limited in their ability to measure submarine signatures, and in 1987 the Navy began development of a new west coast submarine acoustic measurement facility near Ketchikan, Alaska.

SCARF was kept available in the anticipation that surface ships, operating from San Francisco, Long Beach, and San Diego, CA, would make the transit to use the site for Surface Ship Radiated Noise Measurement (SSRNM) acoustic tests. There was competition from both a radar site and an acoustic measurement site much closer to the San Diego operating area, and since the fleet preferred the closer sites, the business case never developed to the point of fiscal viability. The Signatures, Silencing Systems, and Susceptibility leadership, recognizing the business environment, closed the SCARF facility.

CIAR was scheduled to be closed once the new South East Alaska Acoustic Measurement Facility (SEAFAC), became operational in 1991. Dismantling had actually begun when Carderock Division was approached by a customer who agreed to pay for all operations and maintenance costs, as well as the dismantling costs, once their programs were completed. CIAR was converted to the Fox Island Laboratory and is still operated today. A new facility to support this customer is being built at Naval Base, Bangor, WA. Once completed, shore facility on Fox Island will be disestablished. Expected completion is late FY 08.

RV Deer Island and *MONOB*

In the late 1970s and early 1980s, East Coast SSRNM tests were conducted at the entrance to AUTEC, Andros Island, Bahamas. The tests used the research vessel MONOB, which was an instrumented barge. At the time the SSRNM program was well funded. In 1982 the SSRNM sponsor approached Carderock Division about the possibility of accepting "ownership" of *RV Deer Island* to be used as a dedicated test platform. The ship was operated in support of the SSRNM program both at AUTEC and the Puerto Rico operating area and also supported the Fleet Acoustic Submarine Test (FAST) program at AUTEC.

In the late 1980s, the program office experienced budget pressures and shifted its tests to a new fixed site at St. Croix. FAST trials were moved to *USNS Hayes*, significantly reducing the *Deer Island* business base. Operating the ship became financially intractable. The core equity, looking at the long-term consequences of the program funding, approached the customer about moth-balling the ship and transferring any further tests to the *USNS Hayes*. An agreement was reached between Carderock Division, the SSRNM customer, and the submarine test program sponsor to use *Hayes* for surface ship tests, and thus *Deer Island* was transferred to the inactive fleet. With *Hayes* operational, MONOB was also transferred to the inactive fleet.

A research and development organization must maintain test facilities to perform research functions for which it is chartered. The organization must first define the minimum facilities that are core to its mission, and then, find the means to sustain and efficiently operate them. In a Navy Working Capital Fund environment, the organization must develop a strong business mentality and resist keeping facilities because they are "nice to have." The business base for these facilities needs to be scrutinized periodically, and a business case analysis performed. Management must make the difficult business decisions to divest itself of facilities which are no longer economically viable. By conducting these business case studies, we are confident we will have a robust set of facilities to meet customer needs.

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TECHNOLOGY & INNOVATION

SCIENCE AND TECHNOLOGY

Facilities Are Key to Advancing Hydrodynamics

By Dr. Thomas Fu

As one of the twelve product areas within the NAVSEA Warfare Centers, the Ships and Ship Systems (S^3) Product Area (PA) is essential to U.S. Navy combat and support operations. It includes all naval platforms–surface ships, submarines, and manned and unmanned surface and undersea vehicles–and their systems and components, which are essential for their operation, mobility, and survivability. Each year, Carderock Division undertakes several projects to demonstrate the importance of the hydrodynamic test facilities to science and technology (S&T) work, as well as the value of the S&T programs to the S^3 PA. The following illustrates how three facilities at Carderock Division benefit S&T projects related to the S^3 PA.

Advanced Surface Ship Simulation and Control

Development of advanced surface ship simulation and control under the Carderock Division Independent Applied Research (IAR) Program is in the second of its three years. The objective of this work is to develop and implement a faster-than-real-time software platform for the automatic control of a ship in waves and wind. The primary goal is to develop a surface ship simulation software environment coupled with an automatic control system for a surface ship maneuvering in wind and waves. The capability developed will not only improve the ship motion simulations, but it will also provide advanced surface ship control systems. Maneuvering data from tests performed in the Maneuvering and SeaKeeping Basin (MASK) at Carderock Division are being utilized in this effort.

A ship model being tested in a scaled open ocean environment. Part of this IAR-funded work is to develop and implement a faster-than-real-time software platform for the automatic control of a ship in waves and wind.
Photo provided by Dr. Thomas Fu.

In the developed framework, a commanded response is delivered to both the ship and to a recursive neural network (RNN) via matching copies of the automatic control system. The RNN, operating in parallel with the ship, is a software simulation, which provides the vehicle dynamics required to implement predictive control and path planning in the ship automatic control system. In addition, the response from both the ship and the reference simulation may be monitored for performance conditions including changes in the expected sea state and wave field. Although the simulation will build upon previous successful RNN model architecture, implementation will require the development of new techniques for describing and coupling environmental models with RNN simulations. The surface ship simulation will enable not only development, but also testing and evaluation of candidate automatic control systems, path planning algorithms, and performance monitoring systems developed using this simulation environment.

Effect of Surface Tension on Bow Wave Breaking

Far-field bubbly wakes produced by the surface ships of today's Navy pose a threat to ship survivability in the presence of an enemy with wake-homing torpedo capabilities. Bubbles produced by the breaking bow wave are swept beneath the hull and persist in the wake for long distances and times. The small size of these bubbles

SCIENCE AND TECHNOLOGY (Continued on page 36)

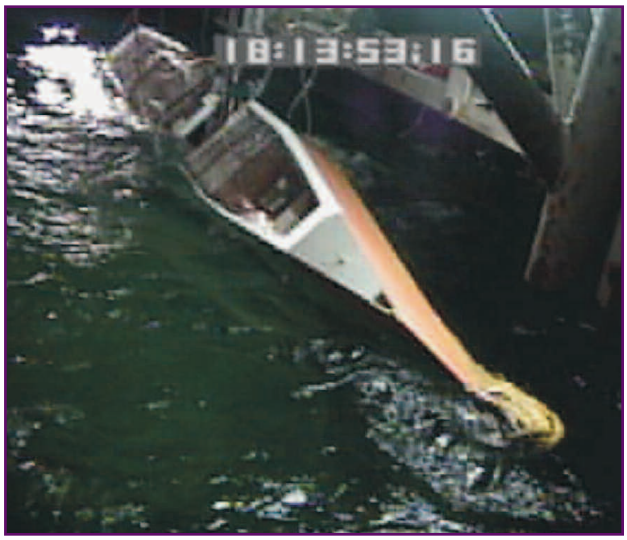
Work on the effect of surface tension on bow wave breaking was performed in the 140-foot basin and towing carriage.
Photo provided by Dr. Thomas Fu.

SCIENCE AND TECHNOLOGY (Continued from page 35)

keeps buoyancy forces from bringing them to the surface. A second important motivation for studying small bubbles entrained near the bow is that they can induce cavitation in the propulsor region. Persistent bubbly wakes are not observed when testing surface ships in the David Taylor Model Basin at Carderock, even with large models that produce significant bow waves. Thus, it would be difficult to develop a model test with the aim of reducing a ship's bubbly wake with current methods. The discrepancy between field observations and model tests is partly attributed to the chemistry of ocean water, including the organic surfactants present on the ocean surface. These surfactants act to lower surface tension in the ocean, reducing the size of the generated bubbles. During the past two years, Carderock Division has worked on characterizing the effect of surface tension on bow wave breaking, focusing on the effects on small-scale surface disturbances and the size distributions of entrained bubbles. This work has been performed in the 140-foot tow basin under the Independent Laboratories In-house Research (ILIR) program.

Constrained Forced Motion Surface Ship Testing

The primary objective of this work is to obtain the model scale constrained seakeeping results to provide information necessary to perform verification of surge, sway, heave, roll, pitch, and yaw forces acting on a surface combatant hull during large amplitude motions and capsize events. This data will be obtained to offer a better understanding of the kinematics of large amplitude motions and capsize events, to help validate calculations in current state-of-the-art seakeeping codes, and to establish a verification database defining large amplitude and non-linear forces and moments associated with large amplitude motions and capsize events. This work, funded by ONR in support of DDG 1000, again shows ONR's direct use of Carderock Division facilities to support S&T work related to the S^3 PA.



A ship model undergoing constrained forced motion in roll to measure restoring forces on the model. Data gathered from this testing helps in understanding the kinematics of large amplitude and non-linear forces and moments.
Photo provided by Dr. Thomas Fu.

The S^3 PA provides the scientific and engineering knowledge, facilities, and expertise for planning and conducting research, development, test and evaluation, acquisition support, human systems integration, in-service engineering, and fleet support for Navy surface and undersea vehicle platforms. The hydrodynamic test facilities at Carderock Division are an essential component of ship design and ship systems development, and in turn play an essential role in the S&T work performed by the Ships and Ship Systems Product Area.

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Ship Integration & Design

This core equity applies specialized expertise for surface and undersea vehicle design including early concept development, assessment and selection of emerging technologies, integration of selected technologies into optimized total vehicle designs, and evaluation of those technologies and designs for cost, producibility, supportability, and military effectiveness.

Machinery Systems

This core equity provides full-spectrum technical capabilities (facilities and expertise) for research, development, design, shipboard and land-based test and evaluation, acquisition support, in-service engineering, fleet engineering, integrated logistic support and concepts, and overall life-cycle engineering.

Hull Forms & Propulsors

This core equity provides the Navy with full-spectrum hydrodynamic capabilities (facilities and expertise) for research, development, design, analysis, testing, evaluation, acquisition support, and in-service engineering in the area of hull forms and propulsors for the U.S. Navy.

Vulnerability & Survivability Systems

This core equity provides full-spectrum capabilities (facilities and expertise) for research, development, design, testing, acquisition support, and in-service engineering to reduce vulnerability and improve survivability of naval platforms and personnel.

Environmental Quality Systems

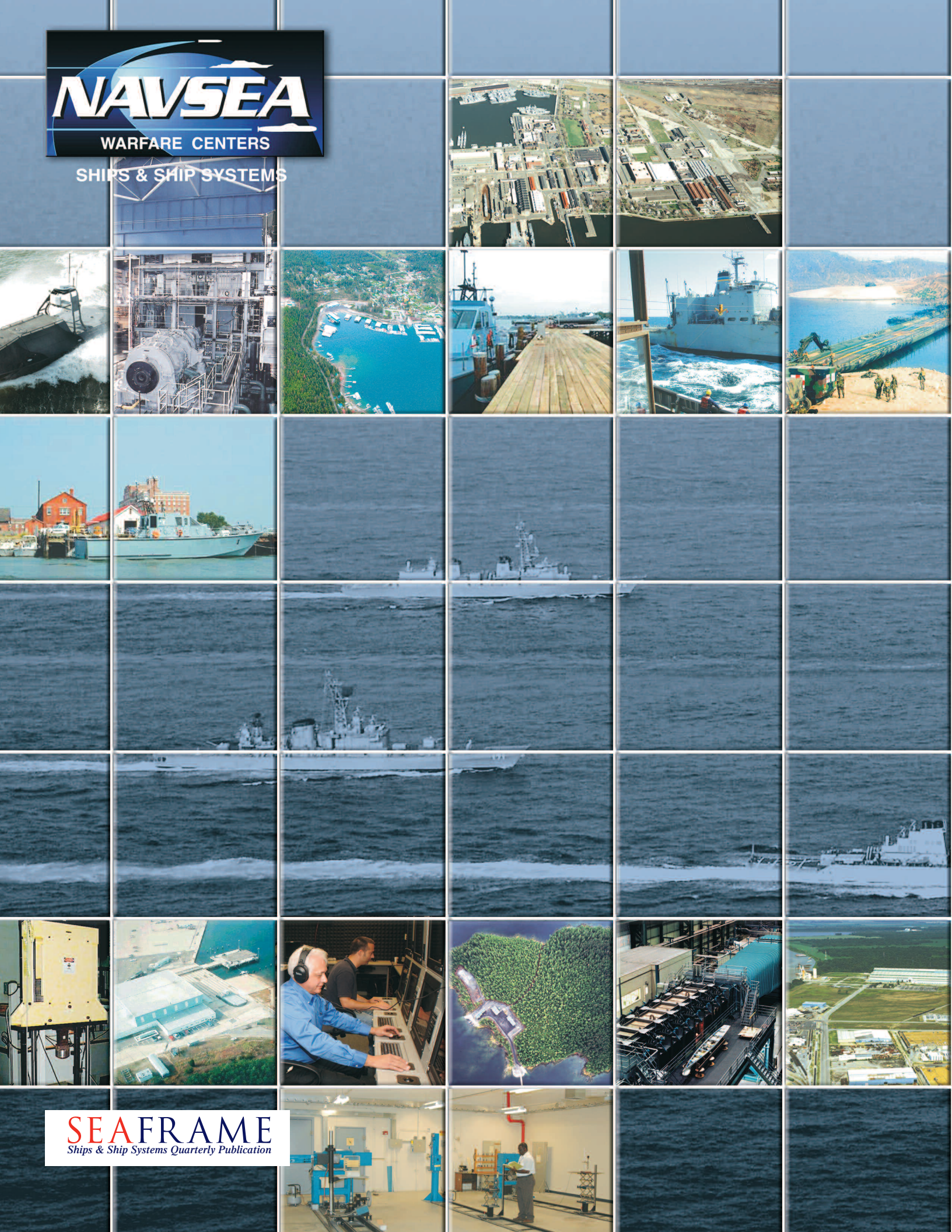
This core equity provides facilities and expertise for research, development, design, human systems integration, acquisition support, in-service engineering, fleet support, integrated logistic concepts, and life-cycle management resulting in mission compatible, efficient and cost-effective environmental materials, processes, and systems for fleet and shore activities.

Signatures, Silencing Systems, & Susceptibility

This core equity specializes in research, development, design, testing, acquisition support, fleet guidance and training, and in-service engineering for signatures on ships and ship systems for all current and future Navy ships and seaborne vehicles and their component systems and assigned personnel.

Structures & Materials

This core equity provides the Navy with specialized facilities and expertise for the full spectrum of research, development, design, testing, acquisition support, and in-service engineering in the area of materials and structures.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